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COSTING NURSING SERVICES BY COMPLEXITY ADJUSTED DRGs

by

Jeanne Francoise Besner

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A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
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Edmonton, Alberta

Spring, 1985

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July 25, 1984

Ms. Jeanne Besner
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This letter will confirm the permission of Medicus Canada for you to include a copy of the Medicus Patient Classification Tool in your thesis.

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We would be most interested in receiving a copy of the results of your study.

Very truly yours,

Ruth E. Robinson

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COSTING NURSING SERVICES BY COMPLEXITY ADJUSTED DRGs

submitted by JEANNE FRANCOISE BESNER

in partial fulfillment of the requirements for the degree of MASTER OF HEALTH SERVICES ADMINISTRATION.

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Date April 12, 1985

ABSTRACT

To achieve control of nursing department expenditures, it is essential that input costs, which reflect the quantity of nursing care provided, be analyzed in relation to patient mix and volume (output). Without this measure of efficiency, the cost implications of changes in case mix or complexity over different time periods cannot be reliably estimated.

This study was undertaken in an attempt to develop a methodology for analyzing nursing costs in a manner which reflects how the budget might vary in relation to the *mix and complexity* of cases treated. Case mix refers to the variety of diagnoses or patient types treated, which determines the amount of hospital resources required.

Complexity was defined as the total quantity of nursing resources required to provide care on a stay specific basis. The Medicus Patient Classification Tool was used to quantify nursing resource use for each day of stay and to assign patients to a complexity subgroup on the basis of a stay specific representative score.

The influence of age, route of admission and condition at discharge on the costs of providing nursing care were also assessed in relation to the patient's medical condition. The Diagnosis Related Groups (DRG) patient classification system provided the basis for detailed analysis of nursing costs in relation to case mix.

Substantial variation in mean nursing costs was found among and within the DRGs selected for this study. Despite this variability, statistically significant differences in mean direct nursing costs were found across the complexity subgroups for most DRGs. Surprisingly little difference was found in the length of stay patterns among patients in differing complexity subgroups within diagnoses.

Advancing age was found to be associated with somewhat higher nursing costs in most DRGs, but statistically significant differences related to age occurred in only seven of the twelve diagnostic groups.

Emergency admission and condition at discharge were also shown to have a statistically significant influence on mean nursing cost in many DRGs.

The findings suggest that the analysis of nursing costs on the basis of a complexity adjusted case mix measure provides a valuable tool for understanding budget variances.

The complexity measure developed for this research was found highly effective in discriminating between groups of patients within and across DRGs who differ in their utilization of nursing resources. It is suggested that the index could be used to compare hospitals on the basis of their case mix and the proportion of nursing intensive patients which they treat.

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1. INTRODUCTION

Escalating health care costs and poor economic conditions in recent years have compelled policy-makers, hospital boards and health care executives to curb increases in hospital expenditures. To achieve control of expenditures, however, requires that costs be scrutinized in a manner which permits analysis of the effect on costs of changes in the nature of the hospital product. Rapid advances in medical technology, an aging population and changing lifestyles have all influenced the nature and complexity of illnesses treated in modern hospitals. The financial impact of consequent changes in patient care cannot be accurately assessed without considering the volume and intensity of services provided (Bahr, 1984).

Traditional measures of hospital output have been vaguely defined in terms of patient days and hours of nursing care provided. These measures implicitly assume homogeneity within and among hospitals with respect to case mix (Bentley & Butler, 1982). They do not allow input costs to be analyzed in relation to the outcome of care and therefore do not encourage the efficient and effective use of hospital resources. Consequently, new approaches to measuring output have emerged, which permit more accurate assessment of how resources are used to deliver specific types of services and provide a more rational method for evaluating patient care. Of these, the Diagnosis Related Groups (DRG) patient classification system is without question the most familiar and widely used case mix measure. In the United States, it now forms the basis of hospital payments for patients covered under the Social Security Act, and is increasingly being used by private insurers to reimburse hospitals according to a fixed rate per discharge. A major shortcoming of the DRG system is its apparent failure to account for differences in nursing care intensity among patients within the same case type. For budgeting, planning and reimbursement purposes, it is essential that these important cost-related dimensions of case mix be captured.

1.1 Statement of the Problem

The nursing department is particularly vulnerable to cost containment efforts, since the nursing budget is generally assumed to comprise 30 to 60 percent of the hospital's total operating costs (Riley & Schaefers, 1983). Recent research has shown, however, that when resource use is analyzed at a patient specific level, actual nursing costs represent no more than one quarter of total hospital expenditures (Sovie, Tarcinale, Vanputee, & Stunden, 1985; Walker, 1983). Furthermore, case based cost analysis allows nurse mangers to substantiate their patient-staff ratios and justify requests for additional funding if necessary. The ability to analyze and compare costs not only in relation to case mix but also to patient complexity is of considerable importance to management. This requires that patient-specific clinical information be tied to a cost accounting system, to permit assessment of how nursing resources are used to deliver particular services to individual patients. Current financial reporting systems in Canada do not lend themselves readily to this type of analysis. Yet, since nursing represents the largest single category of hospital costs, the development of a methodology for analyzing nursing costs which reflects the nature and behavior of hospital case mix would seem particularly rewarding.

The DRG patient classification system is well suited to the analysis of hospital resource utilization. DRGs have a medical orientation, however, and may not adequately reflect the intensity of nursing needs related to patient specific attributes. The allocation of costs within DRGs does not account for differing levels of dependence on nursing staff, which implies that for a given disease condition, each patient receives the same amount of care regardless of day of stay. To refine the apportionment of nursing costs to specific DRGs, improved methods are needed for relating the use of nursing resources to the patient's medical condition. A methodology is needed which permits analysis of how the nursing budget might vary in relation to the mix and complexity of cases treated.

In nursing, patient classification systems (PCS) have been used for several years to rationalize the assignment of staff in response to the differing care requirements of groups of hospitalized patients. PCSs have provided useful information for global budgeting of nursing departments, but they have not routinely been applied to the measurement of patient specific utilization of nursing resources. Although they were not primarily designed for cost allocation purposes, PCSs exemplify an intensity adjusted classification approach which can be adapted to costing nursing services by diagnostic category.

This study was undertaken in order to quantify the cost of providing nursing services to a selected group of patients, taking into account differences in case complexity and associated demands for nursing care.

1.2 Significance of the Study

Econometric analyses have clearly demonstrated that hospitals can be differentiated on the basis of their case mix, and that inputs (and hence costs) vary across case types. Changes in case mix may therefore signal the need to reallocate financial and human resources in accordance with changes in hospital activities (Hornbrook, 1982a). Case mix research has also shown that resource use within a given case type is a function of the patient's illness severity (Horn, 1982). There is growing evidence that in the United States at least, the proportion of acutely ill hospitalized patients is increasing, partly as a consequence of cost containment efforts. With financial incentives to improve efficiency, patients are discharged earlier, often to lower cost health care facilities (Rossen, 1984). Pre-admission services provide another opportunity to lower costs, but result in patients being admitted on the day of surgery, utilizing more resources throughout their hospital stay than formerly. In many areas, physicians are reviewing their admission protocols, to ensure that only those who cannot be treated as out-patients are hospitalized (Punch, 1984). The overall effect of this efficiency consciousness is a reduction in lengths of stay, an increased case flow rate and a higher level of acuity among patients, without necessarily any change in the type of cases being treated. For these reasons, it has become increasingly important for nurse managers to monitor the potential impact of the hospital's case mix complexity on the relative demand for stay specific and case specific nursing resources (Luke, 1979). It is essential that some index of complexity be incorporated in case mix analysis, to ensure that the nursing budget, and if necessary the mix of staff, will be adjusted in response to changes in the level of nursing care needs.

This study should provide useful information to managers about the likely effects of changes in case mix and/or complexity on the cost of providing nursing services. An analysis of whether some case mix groups are more nursing intensive than others, and whether within case types intensity of nursing need varies widely is addressed.

The study should also be of value to policymakers interested in exploring new approaches to hospital funding. Case-based assessment of hospital costs is seriously impeded in Canada by the lack of patient specific financial data in the cost accounting system. This research is a beginning attempt to merge elements of the discharge abstract with a financial account of nursing resource consumption. It should provide a clearer picture of a large portion of the hospital's operating budget, and could provide the basis for calculating patient costs for nursing services received during hospitalization.

1.3 Purpose and Objectives

The overall purpose of this study is to establish a relationship between case mix, nursing resource use and nursing care costs. By linking nursing classification data with clinical patient information, effects on costs of changes in case mix, volume or complexity may be more accurately predicted.

1.3.1 Objectives

Specifically, the objectives of this study are:

1. To assess the contribution of diagnosis to the cost of providing nursing services.

2. To analyze and compare nursing costs in relation to the complexity of nursing care needs.

3. To identify relevant patient attributes which significantly affect nursing resource use and hence costs.

1.4 Assumptions and Limitations of the Study

The results of this study should be interpreted with the following considerations in mind.

1.4.1 Assumptions

- It is assumed that the nursing patient classification system in use at the study hospital is both valid and reliable. An independent assessment of validity is outside the scope of this study. An ongoing program of inter-rater reliability is in place, and it is assumed that all nurses who classified patients during the study period did so in the same manner.

- The study sample comprises all patient discharges classified into thirteen DRGs for the period October, 1983 through March, 1984 at one Alberta hospital. It is assumed the study was conducted during a typical period, and truly reflects the complexity level of patients in the selected diagnostic groups normally treated at that hospital.

1.4.2 Limitations

- The study was conducted in a large, urban, teaching hospital in Alberta. It is well recognized that teaching hospitals tend to treat less common and more complex cases than non-teaching hospitals. The study sample may not be representative of the majority of Alberta hospitals.

- The DRG patient classification system is comprised of 467 disease categories, the majority of which contained too few cases in the study hospital to permit meaningful statistical analysis. To limit analysis of results to a manageable number of patient records, thirteen DRGS were arbitrarily selected for study. These represent but a small portion of the total nursing resources consumed in the hospital during the study period.

- Patient classification systems in nursing quantify the amount of nursing resources required to meet patient needs, but do not measure whether that care is actually given. In this study, care needed is used as a proxy for care received. It is outside the scope of this study to assess whether care required and nursing resources actually consumed are closely matched.

- DRG weights or coefficients represent the costliness of each diagnostic category relative to the total group of 467 DRGs. The weights are used in this study to rank each of thirteen DRGs to demonstrate which represents the greatest use of total hospital resources among the diagnostic groups included. The rank ordering of DRGs may not truly reflect relative differences among the small number of DRGs selected for this research.

1.5 Definition of Terms

The following definitions will clarify some terms used in this report.

1. Nursing resource use: The total hours of nursing care provided to patients grouped into diagnostic types, and based on the consumption of nursing services for each day of stay.

2. Complexity: The total quantity of nursing resources required to provide care to one case during the entire hospital stay (Luke, 1979).

3. Intensity: The quantity of nursing resources required to provide care to one case per day of stay (Luke, 1979).

4. Diagnosis related groups (DRGs): Each patient discharge is classified into one of 467 diagnostic groups which are clinically homogeneous and require similar amounts of the hospital's resources, including medical, nursing and ancillary services.

5. Nursing patient classification system: The categorization of patients according to an assessment of their nursing needs (Giovannetti, 1979).

6. Outliers: Cases involving unusually short or unusually long lengths of stay. They do not typify the average case.

7. Complexity index: the Medicus Patient Classification Tool is used to assign each patient to one of four complexity subgroups on the basis of the stay specific *median* classification score.

1.6 Hypotheses

The following hypotheses will be tested, using analysis of variance (ANOVA) techniques.

1. There is significant variation across DRGs with respect to nursing resource use.

2. There is significant variation within DRGs with respect to nursing resource use.

3. When level of complexity within DRGs is held constant, there is no significant variation in nursing resource use across DRGs.

1.7 Format of the Thesis

The research report is divided into four chapters, in addition to this introductory section. In Chapter 2, some pertinent literature is reviewed. Chapter 3 outlines the research methodology. Analysis of the data is presented in Chapter 4, and a summary of the findings and recommendations are provided in Chapter 5.

2. A SELECTED REVIEW OF THE LITERATURE

The purpose of this literature review is to provide a synopsis of opinion and research on hospital performance. The discussion will focus primarily on issues of relevance to hospital cost analysis and management control. The following areas will be examined: (1) case mix measurement (2) hospital funding mechanisms (3) patient classification systems in nursing and (4) costing nursing services.

2.1 Case Mix Measurement

In any organization, performance is judged according to criteria of efficiency and effectiveness. "An organization's *effectiveness* is measured by the extent to which its outputs accomplish its goals, and its *efficiency* is measured by the relationship between inputs and outputs" (Anthony & Herzlinger, 1980, p. 35). The inputs, which are the labour, materials and services used in the production process are ordinarily expressed as costs, which are a measure of resource consumption. Outputs are not as easily quantified, particularly in service organizations which lack an overall measure of performance comparable to the profit margin and where quality of service is of considerable importance. The heterogeneous product of many non-profit organizations compounds the problem of finding a meaningful measure of total output (Anthony & Herzlinger, 1980).

2.1.1 Defining Hospital Output

That the hospital is a multi-product firm is well recognized. At the turn of this century, Codman (1914) described the challenge in attempting to define hospital output.

> What, then, are the products of a large hospital, whether in the forms of healed wounds, healthy babies, faithful nurses, promising young surgeons and physicians, or in the more abstract forms of original ideas on pathology or treatment, model methods of administration, or such intangible things as enthusiasm and ideals (p. 491).

The lack of clear definition of the output of hospitals has been a serious impediment to policymakers responsible for providing incentives for the cost effective operation of health care institutions (Hornbrook, 1982a). It has also hindered the full development of planning, budgeting and cost control by hospital managers (Bisbee & McCarthy, 1979). From a funding agency's perspective, efficiency enhancement and equitable reimbursement require that hospitals producing similar types and quantities of output be grouped together for comparative purposes (Hornbrook, 1982b). Effective management control demands that hospital activities be described in terms of specific inputs required to produce given levels of output (Fetter, Mills, Riedel & Thompson, 1977; Fox, 1981).

Traditionally, hospital output has been defined in terms of intermediate inputs (such as nursing, medical and ancillary services) required to produce patient care, measured in terms of patient days or numbers of admissions (Dowling, 1976; Fetter, Shin, Freeman, Averill & Thompson, 1980). These measures of output are inadequate in that they fail to explain cost differences among hospitals of similar size and scope of operations. Furthermore, they do not promote the rational allocation of scarce resources, since the quality and cost implications of particular treatment decisions cannot be evaluated in relation to the outcome of individual patient care (Evans, 1971; Fetter et al, 1980). Planning, budgeting, cost control and quality assessment all dictate that financial and patient data be integrated to permit meaningful analysis of hospital performance (Bisbee & McCarthy, 1979; Fedorowicz, 1983). Gross measures of production such as paid hours or costs per patient day, which focus on the providers rather than on the recipients of care, do not encourage efficient nor effective use of hospital resources (de Mora, 1984; Glaser, 1980).

There is general agreement that the diagnosis, or patient type, is a key factor in the measurement of hospital output since it delineates the relevant components of care and provides a basis for predicting the types and amounts of resources required to treat a given patient (Dowling, 1976; Hornbrook, 1982 a,b; Young, Swinkola & Zorn, 1982). The diagnosis also provides a measure of output which is routinely recorded on the medical chart and is comparable across hospitals and within an institution over time (Dowling, 1976). Using the diagnosis as a referent, the heterogeneous product of a hospital can be quantified in terms of the mix and volume of patients it treats (Grywalski & Wright, 1983).

2.1.2 Purpose of Case Mix Measurement

A hospital's overall case mix is comprised of the sum of proportions of differing patient types (Fetter et al, 1980). To measure and compare hospitals according to their case mix, it is necessary to group or classify types of patients along selected dimensions such as disease conditions, consumption of hospital resources or other characteristics (Coburn & Harper, 1983; Hornbrook, 1982a). The choice of dimensions included in the development of a case mix measure is dictated by the purpose for which it is intended. It is unreasonable to expect that any single classification system appropriate for all case mix measurement purposes can ever be developed (Hurtado & Greenlick, 1971; Markel, 1983). For policymakers primarily interested in equitable reimbursement, area-wide planning and evaluation of public programs (Hornbrook, 1982a) a methodology which adequately explains the causes of differences in consumption and costs across hospitals is desirable. For the manager responsible for budgeting, planning, cost control, quality and efficiency, a measure which provides for the allocation of resources to those programs or departments which need them most is ideal (Schumacher, Clopton & Bertram, 1982). Both policy and management decisions, however, require that cost differences across and within hospitals be accounted for in terms of differences in the volume and/or complexity of cases treated (Thompson, Averill & Fetter, 1979).

Two approaches to measuring case mix have evolved, each of which reflects a unique stage in the appraisal of hospital performance. With the rapid increase in hospital expenditures in the late 1960's, case mix research focused on identifying those factors which could best help predict the financial impact of policy decisions regarding the role, size and location of hospitals (Bentley & Butler, 1982). The purpose of this research was primarily to explain the relationship between input costs and outputs across hospitals (Schumacher et al, 1982). In this early research, hospital output was defined largely on the basis of indirect measures such as teaching status and number of medical specialities. These studies revealed that differences in lengths of stay among hospitals were an important factor in determining inter-hospital cost variation. They suggested that cost containment might best be achieved through utilization control. It is therefore not surprising that case mix research then began to concentrate on identifying relevant patient specific attributes which could explain differences in lengths of stay (and hence in costs) among patients within and across hospitals. In this direct approach to case mix measurement, output was defined in terms of the treated case.

2.1.3 Indirect Case Mix Measures

Several indirect approaches to analyzing case mix emerged during the late 1960's and early 1970's, each of which provides some insight into the relationship between hospital costs (inputs) and output. Although these case mix measures are interrelated, each is based on a different dimension of output which can be categorized as follows (Hardwick, 1981):

- Specialty Mix
- Diagnostic Proportions

- Diagnostic Mix and Additional Variables
- Services and Facilities
- Economically Relevant Disease Dimensions

Specialty Mix

In his pioneer work on case mix measurement, Feldstein (1968) postulated that large, non-teaching hospitals could be differentiated in terms of the proportion of their case load which fell into one of eight mutually exclusive specialty categories. Using cost per case and cost per week as dependent variables, he tested the hypothesis that a large proportion of cost variation in his study sample reflected differences among the hospitals in the specialty composition of their cases (p. 295). He found that specialty differences indeed accounted for a substantial proportion of variation in inter-hospital costs, due in part to differences in lengths of stay across the specialty categories. The usefulness of his approach was somewhat limited by the high degree of diagnostic heterogeneity within each of the specialty categories. Since a large proportion of cost variation was left unexplained (about 70 percent), it was obvious that other factors subsumed under broad specialty categories, but related to patient diagnosis, had a significant impact on hospital costs.

Diagnostic Proportions

Evans (1971) endeavored to refine Feldstein's (1968) case mix measure through more in-depth analysis of diagnostic influences. Rather than describing hospitals in terms of their specialty mix, he differentiated them with respect to the proportion of total patient days which fell into each of 41 disease categories derived from the International Classification of Disease-Adapted (ICDA) patient classification system. To minimize heterogeneity within the diagnostic groups, he subdivided them into 40 age and sex categories. Using average cost per case and average cost per day as dependent variables in a regression equation, he found that diagnostic mix accounted for 80 percent of inter-hospital variance in cost per case and 50 percent in cost per day (p. 202). Although his study clearly demonstrated that the mix of patient diagnoses had a significant effect on a hospital's costs, Evans noted that the relative impact of specific diagnoses could not be disentangled using his model. His study revealed that larger hospitals tended to treat more expensive "diagnostic clusters" (p. 210) and to have longer than average length of stay patterns which possibly reflected differences in illness severity. Length of stay was again found to be strongly significant in explaining cost per case, but due to problems of collinearity it was not possible to extricate the separate influences of diagnosis, age and sex patterns on length of stay.

In an effort to explain the effect of particular diagnoses on inter-hospital cost differences, Evans and Walker (1972) used information theory as "an alternative method of adjusting for differences in diagnostic mix" (p. 399). They hypothesized that the more complex cases were likely to be treated primarily in large specialized hospitals, while common problems would be distributed more evenly among all hospitals. The degree of concentration of certain diagnoses in but a few locations was, therefore, a measure of their complexity. An index of relative complexity was developed for each hospital, based on the proportion of its case load falling into each disease class, weighted by the complexity of that diagnostic category (p. 401). Using 98 ICDA diagnostic categories defined along the complexity dimension as independent variables, the researchers accounted for almost 76 percent of inter-hospital cost variation. This study revealed that higher cost hospitals in general were characterized by a different mix of patients than lower cost institutions. The greater the proportion of patients with uncommon diagnoses a hospital treated, the higher its overall cost per case. Higher cost hospitals were again shown to have longer than average lengths of stay, pointing to an interrelationship among cost, case complexity and length of stay.

In both of the above studies (Evans, 1971; Evans & Walker, 1972), it was shown that hospital size per se added little to explaining cost variation after differences due to diagnostic mix were accounted for. Activity variables such as occupancy rate and case flow rate (cases per bed per year) did, however, have a small but significant impact on costs over and above diagnostic mix. Cost per case inevitably increased with length of stay, but decreased inversely with occupancy and case flow rates. This suggests that for a given diagnostic mix, hospitals with shorter lengths of stay and greater volume (i.e., faster turnover) will have lower costs per case. If output is measured in terms of patient days (as was done in these studies) rather than on the basis of treated cases, these hospitals may not appear any more efficient than hospitals with the same complexity of cases but longer lengths of stay and lower turnover (Evans & Walker, 1972). In analyzing the performance of hospitals, it would appear essential to measure output in terms of treated cases, if the goal is to encourage maximum efficiency of operation.

Diagnostic Mix and Other Variables

Lave, Lave and Silverman (1972) used patient discharges as a measure of output in their study of hospital cost determinants. In addition to assessing the influence of factors such as hospital size and teaching status, they looked at patient related variables which were hypothesized to impact on costs. These included components such as age distribution, payment status, proportion of patients having surgery and commonality of the diagnoses. They found that higher costs were associated with the proportion of difficult cases treated and with teaching status, and that lower costs per case were in part explained by the proportion of self-pay and elderly patients, who tended to use fewer ancillary resources. The variables included in their model explained 82 percent of the variance in cost per *patient day*, but the high degree of collinearity among the variables made it difficult to extricate the separate impact of various factors. It is significant that when using the patient discharge as an output measure, the researchers found that costs per patient day increased with length of stay (Lave, Lave & Silverman, 1973). This suggests that patients with longer lengths of stay tend to require more resources per day than others, which is perhaps a reflection of illness severity. This lends support to the work of others who called attention to the relationship among cost, case complexity and length of stay (Evans, 1971; Evans & Walker, 1972).

Services & Facilities

The studies summarized above have shown that hospital costs are a function of the mix and intricacy of cases treated. In general, large teaching hospitals tend to be more specialized and hence they are better equipped to handle the less common and more difficult to treat illnesses. That this is so was demonstrated by Berry (1973) who explored the patterns of facilities and services available in hospitals, to determine whether case mix could be explained on the basis of these factors. He found that those services which were more likely to be associated with case complexity (e.g., ICU, EEC and psychiatric units) were generally found only in large hospitals characterized by 20 or more facilities or specialties. He also found a positive and linear relationship between the number and type of services offered and average length of stay and occupancy rate. This study supported the work of Evans and Walker (1972) and explained why certain diagnostic groups were concentrated in but a few hospitals. It did not address the issue of whether certain diagnostic specific characteristics were associated with greater case cost.

Economically Relevant Dimensions of Disease

Luke (1979) attempted to "identify economically relevant dimensions of disease" (p. 38) in an effort to group and weight cases for differential reimbursement of hospitals. He identified some important dimensions of case mix which should be considered when assessing hospital performance. These were (1) the complexity/prognosis dimension which determined the type of resources required to treat a given case, (2) the intensity of illness which defined the quantity of resources needed by a patient for each day of stay, and (3) the acuity of illness which reflected the immediacy of need and was based on the consequence to the patient of a delay in treatment. In his study, Luke (1979) demonstrated that multiple diagnoses, age over 50 years, case fatality rate and length of stay were valid measures of intricacy, while per diem patient charges and proportion of cases undergoing surgery reflected intensity of illness. The criticalness of illness and the proportion of cases undergoing surgery were found to be useful indicators of acuteness, the latter based on the premise that surgical admissions are often more schedulable and hence less acute than medical admissions. When these measures were collapsed into diagnostic categories and compared across hospitals, it was found that patterns of patient charges (a measure of resource use) and lengths of stay were highly consistent (p. 48). Luke's study was significant in that it attested that many hospital diagnoses and procedures were similar in terms of the resources they required, such that these cases could be aggregated into diagnostic categories which were reasonably homogeneous in terms of cost. This has important implications since it permits the differential costs of hospitals to be analyzed in terms of resource homogeneous patient classes. This is the essence of direct case mix measures which have dominated hospital performance research since the mid-1970's.

2.1.4 Direct Case Mix Measures

With the exception of the last study by Luke (1979), the case mix research summarized above focused mainly on attempting to isolate those factors which could justify cost differences among hospitals. The research question was whether hospital costs could be explained on the basis of factors unique to certain hospitals which made them more costly to operate than others. It was demonstrated that teaching status and size were associated with higher cost hospitals, due largely to the distinctiveness and intricacy of their case mix. In all of the studies, a pronounced relationship between case complexity and cost was demonstrated, but as Luke's work pointed out, a number of factors other than the uncommonness of a disease had to be considered when complexity related costs were analyzed. With growing concern about rising costs in the hospital sector and a proven relationship between cost per case and length of stay, researchers began to probe more deeply into diagnostic specific characteristics which could explain why certain disease groups were more costly than others, and contributed to greater than average lengths of stay. The focus of case mix research shifted toward the development of classification systems which categorized patients according to an assessment of their similarity along a selected dimension. Thus, hospital costliness could be analyzed in terms of the recipients of care, allowing a direct comparison of specific case costs and lengths of stay among hospitals of similar size and role. In addition, an exploration of the cause for differential costs or lengths of stay for specific case types within the same hospital could be undertaken.

ICD-9-CM Disease Classification

The IDC-9-CM case mix measure is an acronym for the 9th Revision of the International Classification of Diseases, Clinical Modification. It is widely used in the United States for the coding of diseases and procedures. It is a five-digit coding scheme which is used "to classify morbidity and mortality information for statistical purposes and to index hospital records by disease and operation for quality assessment purposes" (Hornbrook, 1982b, p. 74). The classification comprises the 17 broad ICD groups categorized into 10,171 cells representing etiology, signs, symptoms, procedures and sites of involvement (Hornbrook, 1982b). The ICD-9-CM groups together patients with the same diagnosis or problem and is therefore highly specific. Each class of patients is clinically homogeneous, but the large number of cells makes it somewhat unwieldy for the purpose of comparing hospitals according to their case mix. In this classification scheme, output is defined as the proportion of a hospital's cases which falls into each of the 10,171 clinical groups.

Hospitals in Canada generally use the four-digit ICD coding scheme for disease classification, as well as the Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures (CPP) for coding of procedures. At the four-digit level the IDC-9 and ICD-9-CM are highly compatible in terms of format and level of detail, but the codes themselves are different (Croke, 1984).

CPHA - List A

The List A classification scheme was developed by the Commission on Professional and Hospital Activities (CPHA) to assist member hospitals to better evaluate the quality of physician performance (Kelman, 1980). It groups ICD-9-CM diagnoses derived from discharge abstracts into one of 398 diagnostic categories subdivided into length of stay homogeneous classes on the basis of age and presence or absence of secondary diagnoses and/or surgical procedures. The resulting matrix is comprised of 7,960 cells, many of which contain very few cases and are of limited usefulness for statistical purposes (Ament, Dreachslin, Kobrinski & Wood, 1982; Hornbrook, 1982b). Each of the patient categories is nonetheless medically meaningful and relatively homogeneous with respect to length of stay. The List A classification allows CPHA member hospitals to compare their average lengths of stay by disease group with peer hospitals, and to identify atypical utilization (Bentley & Butler, 1982). It defines output as the number of patient days experienced by patients grouped into selected categories.

Diagnosis Related Groups

Diagnosis Related Groups (DRGs) best reflect the current state of the art in the development of case mix measures. DRGs are structured using a combination of input (charges) and output (diagnosis) data to produce groups of patients with similar clinical attributes and patterns of resource use. Initially designed to facilitate the review of disease specific length of stay patterns across hospitals (Fetter et al, 1980; Grywalski & Wright, 1983), DRG's now form the basis for the reimbursement of hospitals for in-patient services provided to Medicare beneficiaries in the United States. This has sparked a great deal of interest in and controversy about DRGs (Barnard & Esmond, 1981; Berki, 1983; Doremus & Michenzi, 1983). The last revision of the DRG classification system, based on the ICD-9-CM coding scheme, has only been in use since June, 1983. The bulk of literature on DRGs, however, refers to the earlier ICDA-8 version, and it may be that many of the deficiencies attributed to the classification scheme may prove to be of lesser importance with the new revision.

ICDA-8 DRGs

A detailed description of the construction of ICDA-8 DRGs (sometimes referred to as New Jersey DRGs) is provided by Fetter et al (1980) and is briefly summarized below.

The prime objective in the development of DRGs was to define case types expected to consume a similar amount of hospital resources. The researchers determined at the outset that the usefulness of the classification scheme would be enhanced if (1) the patient groups delineated homogeneous diagnostic categories, (2) the variables defining the patient classes were readily available on discharge abstracts and were known to be associated with differing levels of resource use, (3) the number of classes was manageable while covering the entire range of diseases treated in acute care settings, (4) the classes contained patients with "similar expected measures of output utilization" (Fetter et al, 1980, p. 5), and finally (5) the definition of a class was consistent across available coding schemes. Over 700,000 discharge abstracts from hospitals in New Jersey, New Haven and South Carolina were reviewed (Hornbrook, 1982b; Pettengill & Vertrees, 1980). The hundreds of ICDA codes into which these discharges were classified were initially collapsed into 83 Major Diagnostic Categories (MDCs) through a process of physician review and use of statistical algorithms. One criterion used for defining the MDCs was that the diseases collapsed into each MDC had similar lengths of stay. In addition, each MDC was to be (a) medically meaningful, i.e., the diseases it aggregated were alike in their clinical management, (b) it contained sufficient numbers of cases to make it statistically stable and (c) the MDCs had to cover the complete list of ICD codes without overlap. Length of stay, rather than patient charges, was used as the measure of output or resource utilization since "it is...an important indicator of utilization as well as being easily available, well standardized and reliable" (Fetter et al, 1980, p. 5).

Before dividing the MDCs into subgroups, records of deaths, incomplete abstracts and cases with atypical lengths of stay were removed. The screened records were then partitioned by computer algorithm into clusters, on the basis of predetermined independent variables expected to contribute to variation in length of stay. These were diagnosis, surgical procedure, age, sex and clinical service. For each independent variable, processed one at a time (Williams, Kominski, Dowd & Soper,

1984) the computer procedure created subgroups with similar mean lengths of stay and minimal variance. A clinician then analyzed the computer output and made a decision to "accept, to reject or possibly to revise the recommended partitioning...based on both the statistical evidence and the clinician's medical knowledge" (Fetter et al, 1980, p. 12). There is little published evidence regarding specifically how physician judgement was used in the process (Williams et al, 1984; Young, Swinkola & Hutton, 1981). Groups were then formed on the basis of that variable which most contributed to reduction in length of stay variance and produced a manageable number of medically meaningful subgroups containing at least 100 cases, and with significantly different means. Only 17 percent of the DRGs were formed with age as the primary partitioning variable (Bentley & Butler, 1982; Plomann & Shaffer, 1983). In all, 383 terminal diagnostic groups were formed, arranged in hierarchical fashion such that they could be collapsed into fewer, albeit more heterogeneous, categories if so desired.

Although primary and secondary diagnoses, primary and secondary surgical procedures and age (in some cases) defined the DRGs, there is considerable variation in the structure of each group. Some MDCs are not subdivided, while others may be split into several DRGs, on the basis of some combination of the independent variables (Fetter et al, 1980).

IDC-9-CM DRGs

A new version of DRGs was completed in January, 1982, using ICD-9-CM rather than ICDA-8 diagnostic codes. The scheme underwent changes in the subsequent year to correct reported deficiencies and was finally released in June, 1983. The data base for the ICD-9-CM DRGs consists of over 1.4 million 1979 discharge abstracts from a stratified *national* sample of US hospitals subscribing to CPHA, as well as almost 350,000 patient abstracts from New Jersey hospitals where direct costs of hospital care are routinely calculated (Averill & Kalison, 1984). The new version probably reflects average national lengths of stay much better than before, but since the cost data are drawn from the experience of hospitals in one state only, the likelihood exists that ICD-9-CM DRGs misrepresent average charges levied in many parts of the nation.

In formulating the ICD-9-CM DRGs, clinical judgements of *panels* of physicians and technical advice of experts in patient classification were used extensively. Clinical input by physicians was afforded much more emphasis than in the earlier version, and statistical partitioning of the MDCs was given secondary importance. As well, both the statistical and decision criteria have been made explicit, which should make it easier to evaluate DRGs and improve their meaningfulness and reproducibility when applied to different sets of data (Bentley & Butler, 1982; Cameron & Knauf, 1981; Young et al, 1980).

A major change in the new version is that MDCs have been collapsed into 23 major classes (rather than 83) which broadly define organ systems (e.g., Diseases of the Nervous System). Each MDC is initially dichotomized into a medical and a surgical stream. Rather than partitioning MDCs on the basis of presence or absence of secondary diagnoses and procedures only, decision rules have been used which afford more importance to complications and comorbidities known to significantly affect length of stay (Bentley & Butler, 1982; Hornbrook, 1982b). The age of patients and discharge status (i.e., death) play a greater role in the dividing process than formerly. The result is a new set of 467 diagnostic groups, with three additional categories (DRGs 468, 469 & 470) which contain atypical patients and those for whom coding errors or incomplete data prohibit classification (Averill & Kalison, 1984).

A Canadian version of DRGs has been adapted by the Hospital Medical Records Institute (HMRI), using ICD-9 rather than ICD-9-CM diagnostic codes. The HMRI system is comprised of 23 major clinical categories (MCC) identical to the MDCs and 465 Case Mix Groups (CMG). Because of differences in the coding schemes, it was not possible for HMRI to apply the DRG grouping methodology directly to Canadian hospital discharge data. Congruence between the two systems was maintained as much as possible, and the flow-charts between Major Diagnostic Categories (MDCs) and Major Clinical Categories (MCCs) are virtually identical with the exception of MCC14, Pregnancy, Childbirth and the Puerperium, where replication with MDC14 was not possible because the fifth digit played a more prominent role in splitting the DRGs. The CMGs are sequenced in the same order as DRGs, but gaps have been built into the CMG system to allow for future expansion, such that the numbers assigned to CMGs differ from that of their DRG counterpart (Croke, 1984).

Summary

The DRG classification scheme is comprised of a more manageable number of patient groups that either the ICD-9-CM or CPHA List A methodologies, and therefore lends itself more readily to case mix analysis within and across institutions (Hornbrook, 1982b). It is less specific in terms of clinical management than the other measures since several case types may comprise each patient group (Averill & Kalison, 1984). For this reason, it may be less useful for quality assessment than the others, (Hornbrook, 1982b; Plomann & Shaffer, 1983), although some consider DRGs appropriate for this purpose (Fox, 1981; Fetter et al, 1977). Since patients with atypical lengths of stay (outliers) are excluded from the data base, there is no way to assess whether their unusual stays are related to illness specific characteristics, poor physician performance or other institutional inefficiencies (Hornbrook, 1982b). The scheme was developed using historical hospital data and therefore includes inappropriate patterns of resource use, decreasing its potential usefulness in utilization review (Bentley & Butler, 1982; Plomann & Shaffer, 1983; Williams et al, 1984).

Although the use of discharge abstract information facilitates the collation of data necessary for the classification of patients, the scheme is subject to the usual errors in coding and to the incorrect or incomplete listing of diagnoses which characterize discharge abstracts

(Barnard & Esmond, 1981; Doremus & Michenzi, 1983). All case mix measures which rely on the discharge abstract as a primary source of data share this limitation.

DRGs have also been faulted for reflecting only the present state of medical technology, since they incorporate actual resource use given current philosophy and practice (Bentley & Butler, 1982; Grywalski & Wright, 1983). The developers of the DRG classification fully recognize the need to revise the system to keep pace with changes in the data base and in fact the scheme has undergone constant revision since it was first created in the late 1960's (Fetter et al, 1980).

In general, DRGs are considered a major innovation in the field of case mix measurement. They combine financial and medical elements of the patient's treatment, providing "an operational means of measuring and defining a hospital's case mix" (Averill & Kalison, 1984, p. 72). A major criticism of DRGs is that they fail to account for severity of illness, and hence do not adequately reflect homogeneity in length of stay and costs among patients within diagnostic groups (Grywalski & Wright, 1983; Horn, Sharkey & Bertram, 1983).

From a nursing perspective DRGs are grossly inadequate since no attempt has been made to account for variability of nursing resource use among patients within a diagnostic category. Patient days are used to allocate nursing costs to DRGs, and payment rates for nursing reflect variability in length of stay rather than in need for nursing care (Grimaldi, 1982). Several other classification schemes have been devised, which claim to incorporate illness severity as a primary variable in the grouping of like patients.

Generic Algorithms

Generic algorithms represent a case mix measure developed primarily to assess the impact of surgical procedures and secondary diagnoses on the costs of care, in an attempt to reformulate the DRGs using resource consumption, rather than length of stay, as the dependent variable (Bentley & Butler, 1982). Discharge abstract information was analyzed to determine which secondary diagnoses were associated with the highest mortality rates and longest hospital stays, two variables used as surrogates for illness severity. The degree of invasiveness of a surgical procedure was defined according to whether the procedure was performed in an operating room and involved a major body cavity. The algorithms also separated patients with chronic illnesses from those with only acute diseases listed among the secondary diagnoses. Using these sets of rules, groups of patients using similar amounts of hospital resources were formed, which demonstrated a logical ordering of hospital charges based on the mortality and procedure variables (Bertram, Schumacher, Horn, Clopton, Lord & Chan, 1982). The algorithms are not diagnosis specific and are therefore widely applicable to any patient population. They are useful in identifying those factors, other than primary diagnosis, which contribute to extended lengths of stay and higher costs. Their impact on the reformulation of DRGs is seen particularly with regard to the increased importance afforded to complications, comorbidities, and surgical procedures in the partitioning process. This should significantly increase the clinical and resource homogeneity of DRGs (Hornbrook, 1982b).

Staging

Disease staging was originally developed to monitor the efficacy of various cancer therapies, and was later refined for and applied to the analysis of quality assurance programs (Gonnella & Goran, 1975) and hospital reimbursement schemes (Gonnella, Hornbrook & Louis, 1984).

Staging involves the separation of patients with similar medical problems into four stages defined according to illness severity. Level 1 includes cases of minimal severity with no complications; level 2 those of moderate severity with local complications; level 3 groups all serious problems with systemic complications; and level 4 involves death. Groups of patients expected to require similar therapy and to have similar outcomes were defined by panels of specialist physicians through retrospective chart review. They assessed the results of care, diagnosis and condition at admission and discharge, and factors assumed to have contributed to cure, improvement or progression of disease to a more advanced stage (Gonnella & Goran, 1975). Severity was defined as the risk of death or serious disability related only to the disease condition, and not to the treatment provided (Gonnella et al, 1984). Thus, unlike DRGs and generic algorithms, staging attempts to define case mix groups without inclusion of inefficiencies related to inappropriate care or resource use. Since the groups are defined on the basis of *expected* treatment and outcome, staging is particularly useful for examining physician performance and for assessing the impact of differing approaches to treatment (Plomann & Shaffer, 1983). Although patients in each of the staged groups have similar medical *problems*, they represent a broad spectrum of medical and surgical *diagnoses*, and as such may differ substantially in their use of ancillary services (Butler & Bentley, 1982; Hornbrook, 1982b). A positive correlation has nonetheless been found between level of severity, length of stay and total patient charges within stages (Garg, Louis, Gliebe, Spirka, Skipper & Parekh, 1978).

To date some 470 diagnostic categories have been staged, representing the majority of diseases treated in acute care hospitals (Gonnella et al, 1984). Since each diagnostic category is staged into four severity levels, the resulting matrix contains more than 1600 cells, many of which comprise very few cases, creating a problem vis-a-vis statistical stability (Hornbrook, 1982b). Given the input of panels of physicians into the formulation of the case mix groups, the staging categories have a high degree of medical meaningfulness.

Staging criteria have been developed both for manual application to medical records by physicians or experienced medical records technicians, and for automated application to computerized discharge abstract data. While manual staging probably has a fairly high degree of validity it is too time consuming to be appropriate for large amounts of data (Gonnella et al, 1984). Automated staging, while perhaps more objective, is subject to the problems of reliability associated with the use of discharge abstract information (Barnard & Esmond, 1981; Doremus & Michenzi, 1983).

Staging has been useful for identifying categories of patients in which differing degrees of severity can be expected, and for demonstrating how length of stay and cost vary with severity (Butler & Bentley, 1982). In their study of the staging case mix of a group of teaching hospitals, Butler and Bentley (1982) also noted that while hospitals with a medical school affiliation cared for patients across the entire spectrum of severity, there was a tendency for them to admit more severely ill patients who consumed a disproportionate amount of resources relative to the whole patient population. Staging has also shown that within severity levels, a linear relationship exists between length of stay and increasing age and length of stay and emergency admission, particularly for the lower severity levels (Gonnella et al, 1984).

Severity of Illness Index

The Severity of Illness Index is a method of grouping patients which does not rely on diagnostic criteria and is generic to most medical and surgical conditions treated in acute care hospitals. It is not a free-standing case mix methodology, but is intended to be applied to other measures to differentiate subgroups within diagnostic categories on the basis of illness severity (Horn, 1983; Horn, Sharkey & Bertram, 1983; Horn & Schumacher, 1982). The index was designed to evaluate physician performance and to assist in predicting the costliness of a hospital's case mix (Hornbrook, 1982b).

The Severity of Illness Index is an outgrowth of an earlier patient classification system labeled the AS-SCORE, an acronym for Age, System involvement, Stage of illness, COmplications, and REsponse to treatment (Kreitzer, Loebner & Roveti, 1982). The AS-SCORE was used to subjectively assign patients within DRG groups to a severity level. Similarities and differences in severity within and among selected DRGs were assessed and it was found that considerable variation existed, raising serious doubts about the homogeneity of the DRG categories (Kreitzer et al, 1982).

The AS-SCORE was modified by a panel of physicians and nurses who identified variables presumed to significantly affect severity of illness. The result is a seven variable index defined according to four classes, each of which depicts a different severity level. The seven patient attributes used as variables in the index are (1) stage of the principal diagnosis; (2) concurrent diagnoses expected to affect the course of illness; (3) rate of response to treatment; (4) degree of impairment remaining after treatment is completed; (5) complications of the principal diagnosis; (6) dependency on the hospital staff; and (7) performance of a procedure other than surgery. A rater assigns each patient to one of four severity levels by scoring each of the seven variables on the basis of retrospective chart review. "The rater then selects a severity level for the admission from a four-point scale by implicitly integrating the values of these seven variables" (Horn, 1982, p. 5).

The Severity Index has been found reliable and valid in producing groups which are homogeneous with respect to length of stay and total hospital charges (Horn, Sharkey & Bertram, 1983). Although the time involved in rating each chart is not considered overwhelming (Horn, Chachich & Clopton, 1983), subjectivity in rating is a major disadvantage of the index. Efforts are currently underway to assess the feasibility of automating the index to improve its objectivity and its applicability to large amounts of data (Horn, Chachich & Clopton, 1983).

Patient Management Paths

Patient Management Paths (PMPs) comprise patient classes defined on the basis of the components of care considered appropriate to the clinical management of *typical* patients in each class. The case mix measure was devised primarily to assess the cost and appropriateness of care (Young et al, 1982). PMPs are conceptually similar to the staging mechanism, although in the former, clinically homogeneous groups are defined a *priori* on the basis of admission and discharge diagnoses expected to require similar diagnostic and treatment regimens, while staging is done through retrospective chart review. Both methods classify according to the judgement of panels of physicians and the patient groups therefore have high clinical meaningfulness. In addition, PMPs incorporate variable practice patterns among physicians and institutions, and unlike any of the other case mix measures, they focus directly on the process of care (Young et al, 1982), making them particularly well suited to quality assessment purposes.

To limit the number of categories which would result if all disease conditions were considered, PMP developers have focused on common admission states and signs and symptoms of disease (Bentley & Butler, 1982). For each treatment and procedure considered appropriate to patient management, a cost is calculated and used to estimate the relative cost of each patient category. Computerization of PMPs for use with discharge abstract information is currently underway (Plomann & Shaffer, 1983).

2.1.5 Summary

Several patient classification systems were briefly reviewed, each of which attempts to cluster together patients who are alike on a selected dimension, in order to differentiate them from dissimilar groups of patients. The variables selected in the grouping process derive from the purpose for which the classification is designed.

The DRG scheme built upon earlier case mix research which revealed a conspicuous relationship among case complexity, cost and length of stay. It uses length of stay as a primary partitioning variable to form diagnostic groups which differ in level of complexity across, but are reasonably homogeneous with respect to resource use within the groups.

Disease staging and to some extent, generic algorithms have shown that illness marked by complications tends to result in longer lengths of stay and higher costs with increasing levels of severity. Furthermore, staging research indicates that on balance, teaching hospitals tend to treat more severely ill patients and thereby incur higher costs for a given mix of patients than do non-academic hospitals. Susan Horn (1983) and her associates (Horn, Chachich & Clopton, 1983) have provided evidence that in many cases factors which are intrinsic to specific patients (eg. rate of response to treatment) and totally outside the hospital's control, impact on illness severity and on cost per case.

Direct case mix research has clearly demonstrated that several important dimensions must be considered when measuring and comparing the costliness of hospitals. Differences in case costliness among hospitals of like size and scope can only be meaningfully compared if it can be shown that they are similar in terms of the proportions of severely ill patients which they treat, as well as in their case mix. Likewise, differences in costs and lengths of stay among patients in the same diagnostic groups within hospitals should also be assessed in terms of possible variation in illness severity.

2.1.6 Case Mix Indexes

The classification systems discussed in the previous section reduce large numbers of patient discharges into fewer and more manageable categories to facilitate planning, evaluation and quality control. They summarize hospital output and provide a method for estimating the actual cost of treating a particular mix of patients. To be useful for inter-hospital comparisons of case mix and costliness, however, it is necessary to quantify a hospital's case mix in terms of a single scalar number. "To create a hospital-specific index using a case-mix system with several hundred categories, it is necessary to establish values for each category so that the weighted categories can be combined" (Bentley & Butler, 1982, p. 10). When the coefficient or weight is multiplied by a standard cost, the complexity of the hospital's total output is defined as the costliness of its case mix (Hornbrook, 1982a).

Two prevailing approaches to indexing hospital case mix are briefly described below.

Resource Need Index

The Resource Need Index (RNI), developed by CPHA, reflects the relative resource consumption of a hospital's patient mix (Hardwick, 1981). It was devised using patient charge data from some 2.8 million PAS case abstracts submitted to CPHA for the period 1974 through 1977. For each of the (then) 349 List A diagnostic categories, the average charge for all patients was calculated and expressed as the ratio of that group's charges to the gross charges for all 2.8 million patients. The relationship between the average charge for each diagnostic group and the overall average charge is expressed as a Resource Need Unit (RNU) and reflects the value of resources required by that patient group relative to the total sample. The average patient is assumed to require one RNU, so that a patient with a RNU value of less than one is assumed to require fewer resources than the average patient in that diagnostic category. To quantify the expected effect of case mix on the consumption of hospital resources, RNUs are calculated for each patient and summed across all diagnostic categories. This value is the hospital's Resource Need Index. A RNI of less than one suggests that a given hospital's case mix is lean, relative to the average hospital (Ament, 1976a). Assuming that a hospital's average charge for a given type of patient is proportional to the average charge of all hospitals for that type, the charge per unit will have a value of 1. Thus the RNI is a measure of hospital costliness, which controls for case mix and is used to identify hospitals which treat a more or less difficult mix of patients (Ament, 1976b). Since it uses actual charge data as a proxy for resource consumption, any inefficiencies which may exist are built into the system.

A Relative Stay Index can also be calculated on the same basis as the RNI. A hospital with a stay index greater than one is characterized by longer lengths of stay than the average hospital with a similar case mix. Both the RNI and the Stay Index may be calculated for the entire hospital or for selected departments within a hospital (Hardwick, 1981).

Medicare Case Mix Index

The Medicare Case Mix Index was developed by the Health Care Financing Administration (HCFA) using a sample of Medicare inpatient billing forms and other cost data compiled by HCFA. Patients were first classified into appropriate DRGs on the basis of diagnostic and procedure data derived from the billing forms. Two steps were involved in the development of the hospital index.

Firstly, a cost per case was calculated, and for each DRG the average cost of treating all patients in that diagnostic group was determined, to obtain an expected cost per case by DRG. Patients with atypical lengths of stay (outliers) were excluded prior to calculating the DRG rates. An index of relative costliness for each DRG was determined, by calculating the ratio of the average DRG cost to the average cost for all DRGs.

Secondly, a hospital specific cost per case was calculated by summing the products of the cost weights for each DRG by the number of Medicare patients in that DRG. This process was intended to reflect the overall burden of Medicare cases treated by each hospital. A national expected cost per case was then derived by aggregating and averaging that of all hospitals. The Medicare costliness index of a given hospital is expressed as the ratio of that hospital's DRG-weighted cost per case relative to the national average cost per case for Medicare patients (Coburn & Harper, 1983).

A major criticism of the HCFA Index is that it could create unintended windfalls or penalties in reimbursement. The charge data used in creating the index was derived from an elderly population, which is known to experience longer lengths of stay than the general population from which DRGs were created. By excluding outliers from the data base, it is felt that the case mix index is lowered, resulting in potential underfunding (or perhaps overfunding), depending on the actual Medicare case mix for the base year during which the index is formulated (Bentley, 1981; Coburn & Harper, 1983). It is expected, however, that as case based reimbursement is implemented, the quality of the data used in formulating the index will improve, and hence many of the problems associated with the HCFA index will eventually disappear (Pettengill & Vertrees, 1982).

In summary, case mix indexes represent the final step in measuring the relative costliness of a given hospital's case mix, compared with an overall average case mix for all hospitals. Case mix indexes are used to group like hospitals together for comparative and funding purposes.

2.2 Hospital Funding Mechanisms

Expenditures in the hospital sector have three main components. Increased costs may be related to higher input prices for a given mix of patients, to an increase in the volume or complexity of the case mix, or to improvement in the quality of services provided, the latter of which is extremely difficult to measure (Hornbrook, 1981).

A review of national health expenditures in Canada during the past several years reveals that much of the rise in health care costs can be attributed to higher input prices. In constant 1971 dollars, a fourfold increase in costs occurred between 1960 and 1982. The per-capita constant dollar expenditures for health care during that period rose from $165 in 1960 to $445 in 1982, a 169 percent increase. Between 1978 and 1982 alone there was a 13 percent increase in the constant dollar expenditure per person. The proportion of the gross national product expended on health care in Canada remained relatively stable between 1971 and 1981, at a range of 7.0 to 7.6 percent. Preliminary data for 1982, however, reveal that the figure has risen to 8.4 percent, which is the largest ever recorded. In the United States, the percentage of the gross national product spent on health care, unlike that in Canada, has shown a steady increase since the 1960s and has exceeded the Canadian figure since 1970. Preliminary data for 1982 estimated that 10.5 percent of the GNP in the United States was spent on health care (H&W Canada, 1983).

Among the various categories of health expenditures, the institutional sector (general and allied hospitals) comprises the largest single recipient of health care spending. The percentage of health expenditures accounted for by this sector increased from 28.2 percent in 1960 to an estimated 40 percent in 1982.

In both Canada and the United States, the proportion of health expenditures financed by the private sector has declined since 1960, coinciding in Canada with the introduction of the Medical Care Insurance program and in the United States with the Medicare program. Only 26 percent of health care expenditures in Canada were privately financed in 1981, compared with about 58 percent in the United States (H&W Canada, 1983).

In addition to the increase in input prices, there is some evidence to suggest that higher costs in the hospital sector may be related to changes in case mix or complexity. Given the distinct relationship between case complexity and length of stay, an increase in average length of stay of hospitalized patients over a period of time might signal changes in case complexity. In 1973, the average length of stay in all general hospitals in Canada was 9.45 days; in non-teaching and teaching hospitals the figure was 8.75 and 10.89 days respectively (Statistics Canada, 1974). By 1982-83, the average length of stay in general hospitals had risen to 10.35 days. Non-teaching hospitals recorded an average of 9.98 days, while teaching hospitals experienced an average length of stay of 11.32 days (Statistics Canada, 1984). The increased length of stay is somewhat difficult to interpret in the absence of other supporting data, but given the high average per diem cost of patient care (about $272.00 in 1982-83), its contribution to total hospital cost increases is quite significant.

In view of these statistics, it is understandable that governments have exerted growing pressure on boards and administrators to curb increases in hospital costs. Governments have also begun to explore new methods for funding hospitals, to promote increased efficiency of operation and facilitate the rationalization of hospital expenditures. Under traditional full-cost hospital reimbursement, funding has been based on previous years' expenditures, with annual increases for inflation. Hospital deficits in Canada, at least until recently, have generally been picked up by the funding agency. In the U.S. cost overruns have frequently been passed on to government by cross-subsidizing private patients with Medicare billings. This system provides little incentive to hospital administrators or physicians to hold down cost increases, and is in fact a direct invitation to waste (Dowling, 1974; Soderstrom, 1978). Governments are now seeking new systems of payment which will allow their share of costs to be more predictable over time, by shifting the risk of cost overruns to the hospital itself. A number of schemes have been implemented, with varying degrees of success.

2.2.1 Prospective Payment Systems

Prospective reimbursement is payment based on a formula negotiated before service is provided and which remains firm irrespective of the actual costs incurred (Dowling, 1974; Lave et al, 1973). Because it shifts the risk of deficits to the care provider, it motivates hospital managers to anticipate future costs, to monitor the financial implications of services provided and to keep costs below established rates (Dowling, 1974). Under prospective payment systems (PPS) the consequences of unnecessarily prolonged lengths of stay and abuse of resources are borne by the hospital (Plomann & Shaffer, 1983). Because it promotes efficient hospital management, prospective payment is frequently referred to as incentive reimbursement (Yoder & Connor, 1982). An underlying assumption of prospective reimbursement is that efficiency can earn the hospital a surplus, even though total revenues may decrease once full costs are no longer reimbursed.

There are two main components to prospective payment - the method of control and the unit of payment (Dowling, 1974). The funding agency may exert control through a cooperative or competitive approach. The Canadian system, in which payment levels are mostly established by negotiated agreement, reflects the cooperative approach. The United States has selected a more competitive route, and is phasing in a system of national fixed rates per discharge for its Medicare beneficiaries. Once firmly established, all hospitals will be expected to keep costs at or below fixed rates, or incur losses. In that type of system, there is little room for negotiating rate changes on the basis of losses incurred.

Alternative payment units include global budgeting, departmental budgeting; capitation; rates set according to episodes of illness, specific services provided, case or stay, or per diem fixed rates (Dowling, 1974). Some prevalent payment methods are described below.

Fixed Price Incentive Reimbursement

Some of the earlier efforts to contain costs through improved efficiency began in the early 1970s. Groups of like hospitals (in terms of size, location and teaching status) were formed and allotted a maximum per diem payment, derived on the basis of the mean group cost. If a hospital's average cost per day exceeded that of peer hospitals by more than 10 percent, the hospital was reimbursed at the ceiling rate only. Cost savings were shared with the hospital. Although theoretically sound, this form of payment was shown to institutionalize the behavior of the higher cost hospitals in the peer group. The lower cost hospitals experienced higher than average cost increases, bringing their expenditure pattern more in line with their higher cost peers (Lave et al, 1973). The per diem rate was considered an inappropriate unit of output since it encouraged manipulation by hospital managers to increase total revenues through longer lengths of stay (Evans & Walker, 1972; Glaser, 1980, Kinzer & Warner, 1983; Ro & Auster, 1969). Fixed incentive reimbursement was also criticized for its failure to recognize differences in case complexity among peer hospitals, penalizing those with higher costs related to a more complex case mix (Rafferty, 1971). Glaser (1980) notes that incentive reimbursement cannot ever be totally effective because hospitals see it as ultimately reducing their budgetary bases.

Global Budgeting

In global budgeting, a negotiated lump sum payment is made to cover a hospital's anticipated expenses over a specified period of time. The amount of payment is a function of historical costs, adjustments for inflation, planned or expected volume increases and approved program expansions. Global budgeting is currently the practice in all Canadian provinces. The system is relatively simple to maintain and provides to hospital managers a substantial degree of autonomy in allocating resources within the institution (Medicus Canada, 1982). Accreditation requirements ensure that acceptable standards of care are maintained, while governments control the scope of services by limiting bed capacity and approving expansions (Glaser, 1980).

Because global budgets are derived from historical expenditures, they tend to internalize behavior characteristic of the base years, thereby often rewarding inefficiency (and perhaps penalizing efficiency). Cost control under global budgeting is input-oriented and therefore in and of itself this type of budgeting does not promote efficient operation (Yoder & Connor, 1982). Global budgeting is also insensitive to changes in case mix volume or complexity, and does not operate on the basis of output measures which managers can use to back up their requests for legitimate funding increases to cover changing activity levels (Glaser, 1980; Medicus Canada, 1982). If deficits are incurred, cutbacks in service are often the hospital's only recourse, and quality of care may be compromised. As with other forms of prospective payment, global budgeting may lead boards and managers to find perverse methods for cutting costs (Glaser, 1980).

Quebec is now experimenting with a modified form of global budgeting. Statistical methods are used to cluster hospitals of similar role and case mix and global budgets are established for each peer group. The financial performance of each hospital is evaluated and compared in relation to the group's performance using input indicators such as paid hours and cost per patient day. Hospitals which, during the base year, were better funded than their peers may have some resources withdrawn if they are in a surplus or equilibrium position, to bring their level of financing more in line with the group mean. For those in a deficit position, measures such as bed closures may be used to achieve resource reduction. The formula is used to allocate and redistribute the province's total institutional budget among its hospitals (Lance, Contandriopoulos & Nguyen, 1979).

This funding approach has been criticized by the province's hospital association, which claims that the clustering methodology accounts for no more than 60 percent of the variance in costs among peer hospitals, many of which are grossly underfunded. There are serious concerns about the hospitals' ability to maintain adequate quality levels, particularly in view of an announcement by the provincial government that it intends to recover over $420 million over a five-year period from hospitals judged to have been overfunded (AHQ, 1982).

Departmental or Program Budgets

One approach to prospective payment currently being examined in Alberta is program costing, a method by which "overall hospital operating costs are represented in terms of the cost of providing services to its patients through its patient care programs" (Medicus Canada, 1982, p. 95). Under this system, in-patient operating costs are allocated to all approved programs, to arrive at an average program cost per patient stay. Separate costs are calculated for out-patient services and allocated to each program on a per visit basis. Funding levels are determined by separating costs into fixed and variable components, and budgeting according to projected volume. Cost overruns occasioned by unexpected changes in case mix or volume are reconciled retrospectively. Cost differences among hospitals are assessed on the basis of each hospital's role and the unique programs it provides. Program budgeting is sensitive to case mix changes (Medicus Canada, 1982) but it does not directly account for differing severity or nursing intensity levels within specific programs, which may contribute to higher costs. Departmental or program budgeting is considered a relatively good measure of resource use, but it is administratively burdensome and not necessarily conducive to efficient case management (Yoder & Connor, 1982).

Case Based Funding

In case based funding, the hospital is reimbursed at a predetermined level for each patient discharge (Kinzer & Warner, 1983). Unlike other payment systems, case based reimbursement focuses directly on the patient, and provides an opportunity to analyze costs in terms of the hospital's day to day activities, since output is defined as the treated case (Yoder & Connor, 1982). It does, however, necessitate the integration of administrative, financial and clinical data and is not particularly well suited to an input-oriented cost accounting system, such as that found in Canadian hospitals. Per case reimbursement is based on the premise that individual patients can be clustered into groups which require similar clinical management and consume similar amounts of resources (Berki, 1983). Case based funding provides powerful incentives to contain costs by standardizing the cost per patient type, and allows accurate comparisons of inter-hospital performance, controlling for case mix (Williams et al, 1984).

Funding mechanisms should ideally help to maintain adequate levels of quality, promote clinical excellence, facilitate internal and external control, ensure equitability across hospitals and allow regulators and managers to accurately predict budgetary needs over time (Berki, 1983). Funding should also incorporate efficiency incentives, directed at both the administrative and medical hierarchies (Young & Saltman, 1983). As well as protecting the hospital's economic viability, a reimbursement scheme should define output in such a way that differences in costs due to differences in efficiency are highlighted (Williams et al, 1984). Case based reimbursement is perhaps the most likely funding scheme to potentially meet all of these requirements. Recognizing that case based payment provides the best opportunity to contain costs in the hospital sector, the U.S. government mandated that all hospitals treating Medicare beneficiaries were to be reimbursed on this basis, starting in 1982. The

DRG patient classification system has been the backbone of case based funding to date.

DRG Based Reimbursement

DRG based reimbursement was initially developed and implemented in New Jersey during the period 1978 to 1982. The data base used in designing the scheme comprised all in-patient discharges from the state's hospitals. Charge data obtained from patient bills were used as a surrogate for resource consumption. All out-patient charges were excluded from the calculations, since DRG payment is specific to the in-patient population. Patients who died and those with atypical lengths of stay were also removed from the data base. For each DRG, high and low cut off points were established to exclude atypical cases (outliers). Two special DRGs were created for low and high outliers, and for these patients (including deaths) payment to the hospital continues to be made on the basis of reasonable costs incurred.

Four groups of cost centres were defined:

1) Ancillary cost centres: These are considered 100 percent variable and are allocated on the basis of patient charges. They include costs for services such as x-ray and laboratory.

2) Routine cost centres: These include nursing services and are also defined as 100 percent variable with volume. Nursing costs are allocated on the basis of a per diem rate, pending research to develop a more appropriate cost allocation statistic.

3) General service cost centres: Costs associated with laundry, dietary and all other support services are allocated to patients after first being allocated to direct patient care (ancillary & routine) or to indirect cost centres. These are considered to vary less than 100 percent with volume.

4) Indirect cost centres: 100 percent of fixed costs, including utilities and administration not allocated to direct patient care are allocated to each DRG as a uniform percentage markup of the direct care cost of that DRG.

It was determined that about 60 percent of each patient's total costs were linked to direct care received while the remaining pertained to indirect services (Davies & Westfall, 1983).

Hospital specific DRG rates were calculated after equalizing for differences in pay scales and wages in different geographic regions. Two standard costs were computed, to reflect expected cost differences related to teaching and non-teaching status. A hospital's actual average cost per DRG was blended with the statewide average for that DRG, using the appropriate standard.

Rates for indirect costs were established on the basis of median costs for each cost centre in the two hospital peer groups (teaching and non-teaching). In the New Jersey prospective payment system (PPS), costs related to capital provision, building replacement and so on were not calculated for specific DRGs. A distinctive feature of the New Jersey PPS is that the state's hospitals were reimbursed for all in-patients during the implementation process, irrespective of third party payor (Davies & Westfall, 1983).

During the New Jersey implementation phase a number of important issues were raised, not the least of which was the costliness and intricacy of maintaining the payment system on an ongoing basis. The homogeneity of DRGs with respect to resource use was seriously questioned (Davies & Westfall, 1983; Doremus, 1980) prompting many revisions to the DRG system (see section 2.1.4). The actual improvement in the system from a reimbursement perspective has yet to be determined (Davies & Westfall, 1983).

Notwithstanding the difficulties encountered during the New Jersey implementation phase, the Tax Equity and Fiscal Responsibility Act (TEFRA) mandated DRG-based reimbursement for the nation's Medicare patients in December, 1982. Initially, hospital payments for each Medicare discharge will be based on a blend of hospital specific and national average costs per DRG, calculated in much the same manner as in the New Jersey payment system. Congress amended the Social Security Act in 1983, and announced a four year phase in period during which rate differences among hospitals are to be gradually withdrawn. It is expected that by 1987 most Medicare payments will be made on the basis of uniform national DRG specific rates adjusted for regional wage differentials. Separate standards will be applied on the basis of teaching status and urban/rural location. Payments for outliers are to be limited to between five to six percent of a hospital's aggregate prospective payments (Grywalski & Wright, 1983). This appears aimed at dampening the temptation to manipulate revenues through extended hospital stays, since outliers will continue to be reimbursed on a reasonable full cost basis. All capital related and direct medical education costs will also be reimbursed on a full cost basis, but Congress has requested that a formula to incorporate these costs in the DRG rate be devised by October, 1986 (Prospective Payment, 1983). Specialty hospitals, such as pediatric, psychiatric, long term care and cancer institutions are excluded from DRG based reimbursement. Although federal prospective payment currently applies only to Medicare patients, private insurance plans such as Blue Cross and Blue Shield are beginning to move toward DRG based reimbursement in several areas (Berger, 1984; Oklahoma Hospitals, 1984). In Canada, at least one provincial government has begun to examine the possibility of converting to a DRG based payment system (Markel, 1983; Zuckerman, 1983).

2.2.2 Issues in Case Based Reimbursement

The use of case based measures for hospital cost analysis is worthwhile only if it contributes significantly to improving equity in reimbursement and enhances the quality of information available to management (Doremus, 1980; Watts & Klastorin, 1980). Otherwise, the expense of collecting patient specific cost and clinical data could well outweigh any potential benefit of direct case mix measurement. There seems little doubt that the inclusion of detailed variables such as diagnosis, patient age, admission status, prognosis and illness severity provides important information for hospital cost analysis (Goldfarb, Hornbrook & Higgins, 1983; Kinzer & Warner, 1983; Schumacher, Horn, Solnick, Atkinson & Cook, 1979). Although proxy variables such as hospital size and teaching status are useful predictors of hospital cost they do not provide the same level of detail as do direct case mix variables (Watts & Klastorin, 1980). Research has demonstrated that age, prognosis and illness severity are among the most important patient specific predictors of hospital cost per case (Goldfarb et al, 1983; Schumacher et al, 1979). Illness severity is particularly important in explaining differences in length of stay and use of ancillary services across diagnoses, although personal, clinical, physician and hospital characteristics all play a part in affecting both length of stay and resource use (Goldfarb et al, 1983).

Research has demonstrated that no combination of direct case mix variables has succeeded in fully explaining the total variance in inter-hospital costs (Watts & Klastorin, 1980). Given that DRGs form the basis of case based payment in the U.S., it is not surprising that they have been used as the yardstick against which other patient classification systems have been measured.

In their study of within hospital cost variance among case types, Ament et al (1982) compared the suitability of DRGs, CPHA List A and staging methodologies for explaining variance in patient charges. They found all three methods inappropriate for reimbursement purposes. List A and DRGs were very similar in the proportion of charges accounted for by case type, each explaining no more than 50 percent of the variance. It was felt that differing levels of severity may have accounted for heterogeneity in patient charges within diagnostic categories. Staging was less successful than the DRGs and CPHA classifications at accounting for variation in total charges. The inability of staging to provide substantial improvement in charge homogeneity despite its focus on illness severity is not surprising, since the patient groups are formed according to similarities in medical problems, but may differ markedly with respect to utilization of hospital resources. A terminal patient may be assigned to stage three while receiving little more than supportive care throughout hospitalization. In general, however, progressive increases in patient costs correlate with advancing disease stages, and it has been demonstrated that the most severely ill patients tend to utilize more ancillary services and to experience longer hospital stays (Garg et al, 1978). Nonetheless, if no more than one half of the cost variation by disease type within an institution is accounted for by the case mix measure, it is obvious that staging, along with DRGs and List A, would result in serious payment inequities if used as the basis for cost reimbursement.

There is substantial evidence that any case mix measure used in hospital cost analysis must account directly for illness severity if variation in costs is to be minimized. Of the classification systems in current use, the Severity of Illness Index appears superior to DRGs, Staging, Patient Management Paths and Generic Algorithms in producing groups of patients requiring similar amounts of hospital resources, and experiencing similar lengths of stay (Horn, 1983; Horn, Sharkey & Bertram, 1983; Horn & Schumacher, 1982). It appears, however, that although severely ill patients tend to be hospitalized for longer than average periods of time, not all patients with prolonged courses in hospital are necessarily severely ill or consuming above average amounts of resources per day of stay. Elderly patients (65 years and over) have been found to use fewer ancillary resources per day than average (Lave et al, 1972) while nonetheless experiencing longer than average lengths of stay, which significantly affects total charges per discharge (Kinzer & Warner, 1983).

In addition to providing some very useful information about cost differences within diagnostic categories, the severity measure can be used to assess severity distributions and related cost differences across hospitals. In her study of different types of hospitals (academic and community teaching and non-teaching), Horn (1982) found that for common diseases such as Acute Myocardial Infarct, no significant differences in severity distribution occurred across hospitals, although charges for a given severity level tended to be higher in academic than in other hospitals. She suggested this was an indication that academic hospitals, which have more sophisticated equipment at their disposal, tend to use it to a greater extent. In four of the six disease conditions studied, Horn (1983) found that academic teaching hospitals were treating a greater proportion of patients at higher levels of severity, predisposing those hospitals to great financial risk under a case based payment system which does not take illness severity into account. When case mix was adjusted for severity, differences in patient charges and length of stay among the three types of hospitals were substantially reduced. This finding lends support to arguments that under DRG based payment university hospitals could be penalized for seeing a larger percentage of severely ill patients than other hospitals (Bergen & Roth, 1984). By classifying patients according to severity within DRG categories, heterogeneity in length of stay and charges can be substantially reduced (Kreitzer et al, 1982). This would allow the development of a payment standard which could more accurately reflect cost differentials related to differing proportions of severely ill patients. The DRG patient classification has been endorsed in principle for use in hospital payment on condition that those limitations in the system related to omission of a severity dimension are corrected (AHA, 1984).

2.2.3 DRGs as a Management Tool

DRGs have been shown to be an effective management tool, enhancing the quality of information about case specific length of stay, use of clinical services and consumption of hospital resources (Korkok, 1983; Rossen, 1984; Thompson et al, 1979).

There is no question that DRG based payment creates strong incentives to improve efficiency by channelling patients to less costly modalities of care whenever possible (Berger, 1984; Pointer & Ross, 1984) and by reducing unnecessarily prolonged hospital stays. Pre-admission services (Punch, 1984) and early discharge planning (Rossen, 1984) are only some of the methods used to ensure that patients who remain in hospital require only those services which cannot be provided on an out-patient basis. Administrators, physicians and financial managers are working together to better understand their most costly DRGs. Physicians are being asked to assess their practice patterns and to develop protocols for the management of particularly expensive DRGs. Admitting criteria are being strengthened to ensure that all patient admissions are warranted (Punch, 1984). Manufacturers of hospital merchandise are gearing their products to foster quicker throughput of patients, allowing hospitals to increase volume thereby spreading their fixed costs (Kuntz, 1984). As a direct consequence of DRG based payment, comprehensive cost accounting systems are being developed to allow management to improve efficiency and productivity (Nathanson, 1984a).

The upshot of this increased efficiency consciousness is that hospital case mix could increasingly be comprised of the more severely ill patients within diagnostic groups. Unless efforts are made to ensure that adequate remuneration is made for services provided, there is a risk that hospital boards and managers will manipulate the system to increase the level of reimbursement (Horn, 1983; Nathanson, 1984b). Classification on the basis of DRG category alone has been shown to be inadequate for reimbursement purposes (Ament et al, 1982; Horn & Schumacher, 1982). Equity in reimbursement cannot be achieved unless hospital stay is further defined according to intensity and intricacy of care.

2.2.4 Summary

Prospective payment, and specifically DRG based reimbursement, emanated from a necessity to curtail cost increases in the hospital sector. It is still too soon to know whether DRGs will be sufficiently successful in containing costs, but an evaluation of the New Jersey implementation of DRG based funding suggests that the system is structurally sound and appears to be doing what its designers intended (May & Wasserman, 1984). What has become very obvious is that DRGs are changing the way in which hospitals are managed. They have accelerated the development of sophisticated management information systems (May & Wasserman, 1984; Nathanson, 1984a), have given increased status to Medical Records departments, have expanded the role of the medical staff in financial decision making (Punch, 1984) and have shifted the emphasis from management by inputs to management by outputs (May & Wasserman, 1984). It is difficult to envision that they are but a passing fancy.

Case mix research has nonetheless clearly demonstrated that DRGs are far from perfect from a cost analysis perspective, since they inadequately reflect differing levels of resource consumption among patients within diagnostic categories. The Severity of Illness Index (which is not a free standing case mix measure) has been shown to improve the resource homogeneity of DRG categories by creating subgroups of patients who are differentiated on the basis of illness severity. The methodology seems particularly well suited to an analysis of whether heterogeneity on some dimension other than illness severity also exists within diagnostic groups.

2.3 Patient Classification Systems in Nursing

Patient classification in nursing represents the "categorization of patients according to some assessment of their nursing care requirements over a specified period of time" (Giovannetti, 1979, p. 4). A patient classification system (PCS) can be employed for determining both the amount of care required by a patient and the category of nursing personnel best suited to provide that care (Abdellah & Levine, 1979; Giovannetti, 1979). The assignment of patients to a category of care is based on parameters which depict acuity of illness, severity of symptoms, emotional or physical dependence on nursing staff and complexity of the nursing interventions required (Alward, 1983).

The impetus to the development of patient classification systems was provided by the need to contain costs and rationalize staffing (Connor, Flagle, Hsieh, Preston, & Singer, 1961). In the absence of such a system, nurse managers must rely on inaccurate, though commonly accepted standards, such as hours of nursing care per patient day, to predict staffing needs. The standard ratios imply that all patients, irrespective of diagnosis or day of stay, place an equal burden on the nursing department. Because they fail to account for the differential needs of individual patients, standard nurse to patient ratios are totally inadequate for estimating nursing resource requirements (Buchan, 1979).

The total number and variety of classification systems currently in existence is unknown, but it is estimated there are probably over one hundred different approaches, modeled after relatively few commercial systems (Giovannetti, 1979). A recent survey of Canadian hospitals attested that approximately 25 percent of respondents were using a classification system for staffing purposes (CHA, 1982).

2.3.1 Purpose of Patient Classification

The ultimate purpose of patient classification is to match the care requirements of a given number and mix of patients with available nursing resources (Alward, 1983). Patient classification systems are primarily used to identify and quantify patient needs on a daily basis and adjust staffing patterns on nursing units according to the prescribed workload (Buchan, 1979; Giovannetti, 1979). Patient classification is also used for controlling the nursing budget (Bahr, 1984), determining the categories of nursing personnel required (Norby, Freund & Wagner, 1977), planning nursing assignments (Chagnon, Audette & Tilquin, 1977; Kelly & Montgomery, 1982) and in some instances to balance workload by adjusting patient admissions according to availability of nursing resources (Meyer, 1978). With increasing frequency, patient classification is being used to levy patient charges for nursing services received (Curtin, 1983; Hamilton, 1984; Joel, 1983). Although patient classification is not a substitute for the assessment or measurement of quality (Giovannetti, 1979; Jackson & Resnick, 1982) it can enhance quality control by allowing the patient care prescribed to be compared with documentation of the care given (Reinert & Grant, 1981).

The growing scarcity of resources in the hospital sector has raised the importance of patient classification. It is reported that nursing personnel costs comprise at least 30 percent of total hospital operating expenditures (Grimaldi & Micheletti, 1982; Riley & Schaefers, 1983). The nursing department has therefore been particularly vulnerable to cost containment efforts (Walker, 1983). Under DRG based reimbursement it has become imperative to clearly identify the specific costs of nursing per patient, and patient classification has provided an appropriate method for achieving this goal (Hamilton, 1984). Furthermore, patient specific costing of nursing services has clearly challenged the widely held belief that nursing accounts for the largest share of the hospital's operating costs (Sovie et al, 1985).

2.3.2 Design of Classification Instruments

A patient classification instrument is "a scaling scheme in which the underlying continuum can be conceptualized as expressing a quantitative statement of a patient's requirements for nursing service" (Abdellah & Levine, 1979, p. 475). The range of values differentiates patients according to their reliance on nursing staff along a scale which may vary from self-help to total dependence. Two types of classification instruments have been developed - the prototype and factor designs (Abdellah & Levine, 1979).

In prototype evaluation, patients are classified according to a broad description of the typical patient belonging to each of several mutually exclusive categories. In factor evaluation, the more common of the two designs, specific descriptors of care are delineated. The patient is rated on each of the critical indicators and the separate ratings are combined to designate the category to which that patient belongs (Abdellah & Levine, 1979; Giovannetti, 1979). In both approaches the categories represent greater or lesser amounts of care required (i.e. they are ordinal). Although the factor design approach is thought to be somewhat more objective and simple to use (Abdellah & Levine, 1979), some subjectivity is inevitably involved in assigning patients to a category regardless of the type of instrument used (Giovannetti, 1979).

Estimates of the resource requirements associated with each category of care are derived empirically from workload studies using one of two methods to quantify care needs (Giovannetti, 1979): From observational studies, the average time required to care for patients belonging to a particular category is calculated. The total direct care time required for the entire patient population is estimated by multiplying the number of patients in each category by the average care time and summing over all patients (Chagnon, Audette, Lebrun & Tilquin, 1978). In the second method, the time required to perform specific procedures is empirically determined, and workload is estimated by establishing the frequency with which the procedure is performed over a 24-hour period, and multiplying that by the derived standard care time (Giovannetti & Thiessen, 1983).

In both methods, estimates of indirect care time are calculated and added to direct care time to quantify total nursing time required to meet patient needs. In some, direct care time refers to physical care given in the presence of the patient (Jackson & McKague, 1979). In others, preparation and clean-up time are included when calculating direct care time (Chagnon et al, 1978; Meyer, 1981). It is generally estimated that about 15 to 55 percent of total worked hours are spent in providing direct hands-on care, the proportion varying according to the shift worked (Connor et al, 1961).

All patient classification systems cluster the determinants of care into broad components such as personal hygiene, feeding, mobility and frequency of interventions (Jackson & McKague, 1979). Although these general headings are applicable to the patient population in most institutions, the time required to perform the prescribed activities may vary (Jackson & Resnick, 1982). Organizational and structural differences such as nursing modality (team or primary care nursing) and hospital size, and differing staff competencies may affect the time required to perform tasks in particular settings (McKague, 1978). For these reasons, the quantification coefficients based on average standard times must be validated through work analysis studies before any commercial system is implemented in a given institution (Alward, 1983; Giovannetti, 1979). Users of a system can select coefficients developed by similar institutions and adapt them to their own setting, or alternatively conduct their own time studies (Giovannetti, 1979).

2.3.3 Issues of Reliability and Validity

The validity and reliability of patient classification systems are often questioned (Haas, 1984), but users are probably more responsible for any inconsistencies in classification than are the systems themselves

(Jackson & McKague, 1979). Modifications are usually required prior to adaptation of a PCS for any institution (Scherer & MacKenzie, 1980; Plummer, 1976; Youell, 1979), but a substantial portion of commercial systems users nonetheless implement patient classification without assessing the applicability of quantification coefficients to their own situation (Alward, 1983). This decreases the system's validity, and may well contribute to rejection of classification by staff nurses who fear that staffing requirements are often understated (CHA, 1982). To ensure that care descriptors remain valid, it is necessary to make revisions which reflect changing expectations as nursing practice or standards change (Alward, 19[illegible]). A common challenge to validity is that classification systems quantify nursing time required to deliver care, but fail to provide a true assessment of patient needs (Jackson & Resnick, 1982). As Giovannetti (1979) points out, however, "it is unlikely that this validation can ever be shown satisfactorily" (p.7). Research on patient classification has nonetheless clearly demonstrated that patients do receive on average the amount of care prescribed by their specific category (Giovannetti, 1979; Halloran & Kiley, 1984). This renders classification systems particularly useful for the quantification of nursing resource consumption by hospitalized patients.

To improve the reliability of patient classification systems, ongoing rater reliability testing and adequate orientation programs are required (Bahr, 1984).

2.3.4 Summary

Conceptually, nursing classification systems are similar to DRGs in that they group patients according to the intensity of their nursing needs, and each of the categories should therefore be homogeneous with respect to nursing resource use. Patient classification in nursing, however, has traditionally been used to categorize patients on a day to day basis, while DRGs reflect a patient's total use of hospital resources over the entire course of hospitalization. Neither of the patient classification systems accounts directly for differing levels of illness severity within the distinct categories. Insofar as length of stay and illness severity are linearly related, it could be argued that DRGs do incorporate a severity dimension, but research has shown that they are lacking in this respect. Nursing classification systems identify groups of patients whose level of dependence on nursing staff differ; and while the most severely ill patients are likely to require intensive nursing care, a direct link between illness severity and intensity of nursing need has not been tested and should not be assumed. Admission for psychiatric reasons provides one example of patients who may require constant nursing supervision, although their illness would not necessarily be labeled critical or severe.

A major difference between DRG and nursing classification systems is that while DRG coefficients or weights represent relative use of hospital resources, the quantification coefficients in nursing systems are based on absolute nursing resource consumption. Thus while DRGs reflect average use of resources, the patient categories in nursing systems represent the actual amount of resources required to provide an ideal level of care. As long as a direct relationship exists between the use of nursing and of non-nursing resources, significant differences in the average amount of nursing care required should be found across DRGs, which vary in their level of complexity (defined as resource need). For differential allocation of nursing resources to patients with the greatest need this is an important consideration. Research has shown, however, that DRGs fail to discriminate adequately between differing levels of need within diagnostic categories. From a cost analysis perspective this is an important disadvantage. If some hospitals tend to treat patients who require higher levels of nursing care for a given case mix than do others, differential funding of those hospitals is required to maintain their financial viability. Since the nursing budget comprises a significant proportion of the total hospital operating budget, research into appropriate methods for costing nursing services would appear particularly rewarding.

2.4 Costing Nursing Services

The implementation of DRG based reimbursement in the United States has had profound implications for nursing. There is solid evidence that a decrease in average lengths of stay is occurring, associated with a tendency for patients being admitted to hospitals to be more acutely ill and to require more complex nursing care (Donaho & Haas, 1984; Grant, Bellinger & Sweda, 1982). More nursing resources are being expended to provide services but this is not reflected by output measures such as total patient days or even case mix. The ability to analyse and compare differences in resource use among patients is becoming increasingly important for nurse managers. Patient classification systems are now being used to bridge the gap between the types of patients being cared for and the nursing services they require (Donaho & Haas, 1984). Total nursing care required by patients throughout hospitalization is being tracked through the patient classification system to quantify resource use and cost by individuals or by DRG (Bahr, 1984; Maher & Dolan, 1982; Meyer, 1984). Classification data are also being used to project future staffing patterns, in anticipation that patients of higher acuity will necessitate a probable change in the ratio of professional to non-professional nursing staff (Grant et al, 1982; Joel, 1983).

Recognizing that traditional costing of nursing services on the basis of hours of care per patient day is no longer acceptable, researchers are attempting to develop cost allocation methodologies which will relate the intensity of nursing care required to the patient's medical condition. A number of different approaches to costing nursing services are described in the literature.

Relative Intensity Measures (RIMs) were developed by the New Jersey Department of Health to categorize patients into groups requiring similar amounts of nursing care (Grimaldi & Micheletti, 1982). The RIMs methodology is a case mix system which, although patterned after DRGs, is a completely separate method for quantifying "nursing resource use on a patient-specific basis" (Joel, 1984, p. 44). An underlying assumption of RIMs is that the intensity of nursing care required by individuals over the course of hospitalization will fluctuate from day to day. The differential needs of patients for each day of stay were estimated through workload studies, and contributed to the formation of 13 Nursing Resource Clusters (NRCs), each of which is homogeneous with respect to nursing resource consumption. Within each NRC the intensity of care (where one RIM = 1 minute of care) required by each patient was calculated, and averaged for each of the several DRGs contained in an NRC. An assessment of the relative cost of nursing services for each DRG in a nursing resource cluster was obtained. For example, if patients in one DRG received one fourth the amount of time as in another, one quarter of the total nursing costs for that NRC would be allocated to the first DRG, and three quarters to the other. This is the "allocation statistic that is used to apportion nursing costs to each case subsumed under a given output group" (Caterinicchio & Davies, 1983, p. 268). The apportionment of nursing costs is based on the hospital's total nursing budget, such that RIMs are a management information tool which assists managers in identifying those patients requiring greater or lesser amounts of nursing care. The RIMs methodology allows DRGs to be broken down more finely, to understand which DRGs consume more of the nursing budget and why (Joel, 1983).

By averaging nursing resource use within DRGs, there is an implication that all patients in a diagnostic category receive the same amount of care. This compromises the efficiency of DRGs as a case mix measure for use in predicting nursing care requirements (Joel, 1984; Meyer, 1984). An increase in the proportion of higher intensity patients would not be easily recognized under the RIMS methodology. This would not provide nurse managers with the justification required to seek appropriate budgetary increases (Hamilton, 1984). Continued increases in workload without adjustments in staffing could have a negative effect on quality of care (Grimaldi, 1984; Hamilton, 1984). It is essential that cost allocation methodologies directly reflect the intensity of service provided (Riley & Schaefers, 1983).

A recent study carried out at Stanford University Hospital highlights the importance of taking complexity into account when apportioning nursing costs to specific DRGs. The average hours and costs of direct nursing care were determined for selected DRGs (#121, 122, 209, 210). Nursing resource use was found to vary substantially across DRGs and to be distributed differently over the course of hospitalization. Patients within each DRG fell along a continuum from slightly to highly dependent on the nursing staff reflecting a broad range of resource use. Using a nursing classification system, patients were separated into groups, resulting in substantial reduction in the range of nursing costs calculated for each subgroup within a DRG (Mitchell, Miller, Welches & Walker, 1984). This study provides evidence that if the proportion of highly dependent patients within a DRG changes substantially over a period of time, allocating nursing costs on the basis of an average statistic could result in over or underfunding of the nursing department.

Patient classification systems based on intensity of nursing need are a useful method for estimating the cost of providing differing levels of nursing care (Shaffer, 1984; Walker, 1983). Since patient classification estimates only the direct costs of providing nursing care, the indirect or fixed costs (which include nursing administration, in-service education and other support costs) must be added in order to apportion the total nursing department costs to individual patients or to DRGs. The usual method for apportioning fixed costs consists of dividing the indirect costs by bed capacity or total patient days, and allocating that cost on the basis of each day of stay (Maher & Dolan, 1982). Research has shown that direct nursing care accounts for approximately 60 percent of the nursing department's total costs. General administration, management support and ward clerks consume the remaining 40 percent of the nursing budget (Riley & Schaefers, 1983).

2.4.1 Summary

The implementation of DRG based reimbursement in the United States has forced nursing managers to critically analyze their departmental costs or risk budget deficits against which they have no defense. Case based funding is not an issue in Canada, at least for the time being, but cost containment is a reality which every nursing manager must face. There is ample evidence that the quality of information available to managers is enhanced when the costs of providing care are linked directly to the patient's diagnosis. Research into case specific costing of nursing services is still in its infancy, and as yet there has been no report of a Canadian study in this regard. There is nonetheless a recognized need in Canada to develop a methodology which will allow all hospital costs to be allocated in a manner which reflects how "individual hospital services are combined to treat specific types of diagnosed patient problems" (Hundert & Stewart, 1984, p. 34).

This study is a beginning attempt to explore the feasibility and potential benefit of linking nursing classification data to diagnostic categories as a means of analyzing and comparing nursing costs in Canadian hospitals.

3. METHODOLOGY

After reviewing literature on currently available patient classification systems, the DRG system was selected for costing nursing services by diagnostic groups in this research. A number of factors contributed to this decision. The DRG system is the most popular case mix measure in use. It is fully automated, and classification of patients into diagnostic categories requires no subjective judgement. Over 50 percent of all hospital discharges in Canada are classified into DRG equivalent case mix groups and at least some provincial governments are beginning to explore DRGs' potential for future hospital payment. Whether or not DRG-based reimbursement is ever a reality in Canada is a moot point. What matters is that DRGs offer hospital managers a previously unavailable opportunity for detailed cost analysis by allowing them to relate the use of hospital resources directly to case mix. The allocation of nursing costs in the current DRG system is unacceptable, however, because it fails to incorporate adjustments for differing levels of complexity of nursing care among patients grouped in the same diagnostic category. This research was undertaken in an effort to shed some light on the behavior of nursing costs and refine the apportionment of nursing costs to DRGs.

3.1 The Research Design

Alberta hospital discharges are currently classified according to CPHA List A diagnostic codes. One large teaching hospital recently opted to have its discharges also coded into DRGs by the Commission on Professional and Hospital Activities (CPHA). For the period October 1983 through

March, 1984 all discharge data from this hospital were available on computer print-outs on which all pertinent patient information was already coded into DRG groups.

Since classification into a particular DRG depends not only on primary diagnosis but on several other variables considered simultaneously, prospective studies, with sample selection based on common admitting diagnoses, may need to extend over long periods of time before sufficient numbers of patients are available within the DRGs chosen for study. For this reason, it was decided that a retrospective study was most appropriate for this research, and permission was secured to use the hospital's DRG discharge list as a data base.

3.2 Study Sample

The discharge abstract summary for the month of October, 1983 was surveyed to identify potential DRGs for inclusion in the study. It was predetermined that in order to allow meaningful statistical analysis any DRG containing fewer than 60 cases over the six month study period would be automatically excluded. Of the 374 DRGs which comprised the month's discharges, 303 (81 percent) contained fewer than ten cases. To limit analysis to a manageable number of records, it was arbitrarily decided to select twelve DRGs which would provide a total sample of no more than 1500 cases. One additional DRG (#458) was included to provide patient classification data needed for a separate study being carried out at the hospital (Moffatt, in progress). Although this DRG is included in descriptive analysis of the data, its small sample size precludes it from further statistical manipulation. Other considerations which guided the selection of appropriate DRGs are:

1. There should be differences among and within the DRGs with respect to prognosis, admission and discharge status, and expected levels of severity, such that the derived demand for nursing services would differ. This criterion increases the likelihood that differential nursing costs related to varying complexity levels will be captured if they exist.

2. The DRGs should include a cross-section of both medical and surgical diagnoses. There are proportionately more surgical than medical DRGs in the study, which conforms with the status quo at the study hospital.

3. There should be one "male" and one "female" DRG, to provide the opportunity to determine whether sex related differential nursing resource consumption might occur.

4. The DRGs should reflect age differences, but to facilitate cross comparisons, DRGs specific to the pediatric age group should be excluded. DRGs related to maternal and neonatal care were also rejected.

5. There should be substantial length of stay variance across DRGs.

6. The DRGs should span the spectrum of costliness weights assigned to the classification system, so that the consumption of nursing resources can be assessed in relation to the use of total hospital resources implied by the weighting scheme.

These criteria condensed the list of potential diagnostic codes to about 25 DRGS, of which twelve were selected arbitarily, in addition to DRG #458.

The DRGs chosen are itemized in Table 1. The Canadian equivalent diagnostic groups developed by the Hospital Medical Records Institute (HMRI) are given in parentheses. The costliness weights do not apply to the Canadian case mix groups (CMGs).

TABLE 1 DRGs INCLUDED IN STUDY

DRG	(CMG)	TITLE	WEIGHT
#001	(001)	Craniotomy, except trauma, age > 17	3.3548
#088	(113)	COPD	1.0412
#105	(140)	Cardiac Valve Operation, with Pump	5.2308
#107	(142)	Coronary Bypass, no catheterization	3.9891
#122	(157)	AMI, No C.V. Complications, Discharged Alive	1.3651
#148	(193)	Major Intestinal Operation, Age ≥ 70 and/or complication/ comorbidity	2.5493
#162	(207)	Inguinal/Femoral Hernia Operation, Age ≥ 17	.5854
#209	(274)	Major Joint Operation	2.2912
#222	(287)	Knee operation, Age 0-69, without compl/comor	.9897
#335	(445)	Major Pelvic Operation, Male, Without complication	1.3590
#355	(475)	Hysterectomy, Age 0-69, Without complication	1.0156
#430	(595)	Psychoses	1.0934
#458	(643)	Burn, non-extensive, skin graft	2.8572

The DRG weights represent the relative costliness of the categories with respect to total consumption of hospital resources. In relative terms, therefore, the most resource intensive DRG in this study is #105 (Cardiac Valve Op), and the least complex is #162 (Hernia Op). Should there be a direct relationship between nursing resource use and total consumption of hospital resources, DRGs #105 and #162 would reflect maximum and minimum use of nursing resources, respectively. Intuitively, however, one would expect that some diagnostic categories consume proportionately far more ancillary resources than others for a given complexity level and a direct relationship between total consumption of hospital resources and nursing resource use is not anticipated.

It is worth noting that the majority of DRGs in this study have a weight greater than 1.0, indicating they are more costly than average. The choice of DRGs was dictated at least in part by the criterion that there be a sufficient volume of patients in each DRG over the six month period of study. This suggests that the case mix in the study hospital may be more complex than average, a finding which is not surprising since it is a large teaching hospital.

The patient sample represents approximately nine percent (9%) of the total hospital discharges between October, 1983 and March, 1984. The cases comprise a purposive sample, selected according to the researcher's judgment about which DRGs would best meet the objectives of the study. There is potential bias in the selection criteria but this is not considered a major limitation of this study since the main purpose is to examine the behavior of nursing costs within specific diagnoses. All cases in selected DRGs are included, and it is assumed they are representative of the true population of patients with those disease conditions discharged from the study hospital over any six month period. It cannot be assumed they represent in any way the majority of patients routinely treated at that hospital, since more than 90 percent of all discharges are excluded from study. Within each DRG exluding #458, sample size is believed to be sufficiently large to adequately reflect typical nursing resource use.

Five cases were excluded from the study because it was not possible to track their patient classification data. They either could not be located from the time of admission, or were lost at some point during hospitalization. Neither the record of internal transfers nor a search through the patients' medical record provided sufficient information to locate these cases. They include two cases in DRG #107 and one each in DRGs #430, #209 and #088. There is no reason to believe these patients differ in any systematic way from those included in the study.

Table 2 delineates the cases by DRG for each month of the study. The mean length of stay for each diagnostic category is also included in parentheses. At the bottom of the table, total number of discharges and average length of stay for all patients in the study hospital during the six month period are provided. It is immediately obvious that the average length of stay for patients in the study sample far exceeds that for the hospital population as a whole. This is another indication that the study population is more resource intensive than average.

TABLE 2

MONTHLY NUMBER OF CASES AND MEAN LENGTH OF STAY* FOR SELECTED DRGs

DRG	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	TOTAL
001	15(28.1)	16(23.9)	14(14.3)	11(24.5)	11(19.0)	22(27.0)	89
#088	16(17.8)	23(24.6)	15(16.1)	21(24.7)	16(21.1)	20(13.6)	111
#105	13 (9.6)	11(10.7)	5(17.4)	14(26.1)	14(15.1)	10(19.8)	67
#107	22(13.3)	23(10.5)	25(10.9)	18(15.2)	20(14.3)	23(12.3)	131
#122	12(11.5)	10(10.5)	18(13.2)	11(11.3)	18(11.9)	17 (9.6)	86
#148	11(14.8)	16(24.4)	7(46.4)	8(26.1)	14(19.1)	15(31.9)	71
#162	15 (5.4)	10 (4.4)	20(4.6)	12 (4.6)	10 (6.2)	17 (5.8)	84
#209	21(12.9)	17(16.1)	20(23.3)	29(17.5)	22(17.2)	29(17.1)	138
#222	40 (4.8)	28 (4.1)	36 (6.0)	35 (3.5)	49 (3.9)	36 (3.7)	224
#335	27(11.7)	31(11.8)	20(14.8)	11(10.5)	15(12.6)	11(13.5)	115
#355	17 (8.6)	32 (8.7)	23 (9.5)	31 (7.9)	24 (8.1)	31 (8.6)	158
#430	24(22.5)	17(29.8)	17(27.4)	30(25.9)	20(29.2)	26(30.4)	134
#458	5(27.0)	4(34.0)	9(38.9)	4(31.0)	5(28.4)	6(20.2)	33
DRG TOTAL	238(14.5)	238(16.4)	229(18.7)	235(17.6)	238(15.9)	263(16.4)	1,441
TOTAL HOSPITAL DISCHARGES	2679 (9.6)	2664 (9.7)	2684(10.2)	2573 (9.6)	2677 (9.4)	2779(10.7)	16,056

* Figure in brackets represents mean length of stay.

3.3 Description of the Variables

The theme of this research centres on the relationship between two variables which are defined as follows:

3.3.1 Independent Variable

The Independent variable is the patient's diagnostic category or DRG, and its associated demand for nursing resources.

3.3.2 Dependent Variable

The Dependent variable is the cost of nursing care, calculated for each patient for every day of stay and averaged within each DRG. The daily cost of care is determined empirically by converting the patient's classification score to total hours of care required per day of stay, multiplied by an average nursing hourly wage.

3.4 Data Collection Procedure

One objective of this study is to compare nursing costs related to differing levels of complexity among patients within diagnostic groups. Complexity refers to the total quantity of nursing resources required to provide care to each patient throughout his hospital stay. The intensity of nursing care required for each day of stay, measured by the daily classification score, and summed over length of stay provides the measure of complexity. To meaningfully compare groups of patients who differ overall in level of complexity, it is necessary to quantify each patient's total nursing resource use in terms of a single scalar number. The nursing classification data is also used for this purpose, by placing each patient into a complexity subgroup on the basis of a representative stay specific classification score.

The literature on hospital case mix points to several patient specific attributes which impact on the costs of care. These include age, type of admission and criticalness of illness (i.e. risk of death). It is difficult to discern, from the literature reviewed, whether the effect of these variables is more pronounced in some diagnostic categories than in others. This issue is analyzed in this study.

3.4.1 Data Collection Form

The first step in data collection was the development of an appropriate form which could be used for the three-phased process of obtaining patient data (Appendix A).

Part A - Patient Specific Data

Data collection and item coding in section A were done by the researcher. Simple transcription of data from the discharge abstract to the form was involved. The selection of items for this part of the form was largely based on the literature review. A brief explanation of some components follows:

1. Age: It is often reported that age 65 years or greater is associated with higher hospital costs (Duckett & Kristofferson, 1978; Goldfarb et al., 1983), but there are very few studies (Luke, 1979) which address the impact on costs of subdividing the patient population into other age groups. In this study the mean costs of nursing care by DRG are analyzed on the basis of four age distributions - under and over ages 50, 60, 65 and 70.

2. Diagnostic information: It was initially felt that particular ICD-9 diagnoses within the DRGs might help explain potential differences in nursing resource use among patients. A large variety of secondary diagnoses and procedures were found among patients grouped in the same DRG, which suggested that relatively little meaningful information would be gained from the detailed analysis likely required of this component. This information was therefore not used in data analysis.

3. Type of admission: Several factors are likely to influence the level of nursing resources required from the time of admission. The following code is used to classify admissions:

   1. Elective
   2. Emergency/Urgent
   3. Admitted from another acute care facility
   4. Emergency re-admission
   5. Re-admission

   It is assumed that patients in categories 2 to 4 on average require more intense nursing services than those in categories 1 and 5. In each DRG, the validity of this assumption is assessed.

4. Condition at discharge: This is coded as follows:

   1. Alive
   2. Dead
   3. Discharged to an acute care or other facility (eg. nursing home)

   It is expected that patients in categories 2 and 3 require on average a higher intensity of nursing care during the course of hospitalization than those in category 1. The mean costs of care for those patients should therefore be substantially higher.

Part B - Admission, Transfer & Discharge Data

This section, completed by Medical Records personnel, was essential for tracking patients through their hospital stay. Since the study was retrospective, the daily classification sheets used on all relevant nursing units during the six month period had to be extracted from files, maintained in chronological order by unit. The search for a particular patient name could not be carried out unless the unit and date of admission were known. The search ended on the discharge date recorded.

The following points are noteworthy:

1. Patients are not necessarily classified on the day of admission. Classification is routinely done at 0800 hours. Patients admitted after this time are first classified the next morning.

2. Some patients are classified on the day of discharge while others are not. Known elective admissions are often classified instead of the patient who is vacating the bed.

3. Some patients are occasionally allowed out on day or week-end passes. They are not classified unless they require nursing care on that day. Patients out on pass are assigned a direct care value of zero but the day is counted as a day of stay, since the bed is still occupied.

These factors may have some impact on the average lengths of stay within diagnostic groups, but their influence is likely minimal.

Part C - Nursing Classification Scores

This section was completed by the researcher or her assistant, using patient classification data maintained in the hospital's central nursing office. Daily classification forms are completed on each patient care unit and transmitted to the Nursing Audit Department. The forms are filed by unit, in chronological order. For each patient in the sample, classification by day of stay was tracked and recorded. Occasionally, classification forms for one or more days were missing from the files, and no record of the patient's intensity level was available. In those instances the following decision rules applied.

1. If the patient type or intensity level was the same on the day before as on the day after the missing data, that type was assigned to the missing day (or consecutive missing days).

2. If the patient type was lower on the day after than on the day before the missing data, the lower type was assigned. In this way costs are perhaps underestimated, but there is less risk of overinflating true nursing costs for specific DRGs. There is some risk, however, that since daily classification scores are used in the formation of complexity subgroups, some patients will be categorized at a lower complexity level than that in which they truly belong.

The DRGs in which this procedure was necessary and the number of cases affected are as follows:

DRG # 001 = 13
105 = 1
107 = 1
122 = 3
335 = 10
458 = 7

The three DRGs in which substitutions were most often required are surgical categories. It is possible that missing data coincided with operative days, in which case both costs and complexity level may be underestimated.

Seven cases were dropped from further study because their days of stay numbered one or less, and no classification data were available. Two of these patients (one in each of DRGs #148 and #088) died within 24 hours of admission. The others (3 in DRG # 430, and 2 in DRG #222) appear not to have required in-patient services at the study hospital.

3.4.2 Patient Classification

The patient classification system in use at the study hospital is that developed by the Medicus Corporation (Appendix B). This system clusters critical care indicators into three major components which include conditions requiring special interventions, basic care and special therapeutic needs. The critical indicators are clearly defined to minimize the need for subjective interpretation by nurse classifiers.

The system currently used is a four-type classification. In some special care areas, including the Burn Unit and MultiSystems Failure ICU, a fifth patient type has been defined by the study hospital, to reflect the intensive nursing resource use of patients in these areas.

The Medicus system focuses on the Type II patient, who typifies the average hospitalized patient. Each type is assigned a coefficient, or weight, as follows:

Type I = .5
II = 1.0
III = 2.5
IV = 5

The hospital has added a fifth patient type, assigned a coefficient of 10, which typifies the most intensive care patients in the Burn Unit and ICU.

A standard, validated during the implementation of a classification system, is assigned to the type II patient. It quantifies the number of nursing care hours which the average hospital patient requires in a 24 hour period in the user hospital. The standard used at the study hospital was derived through consideration of 1) the modality of nursing, 2) the mix and expertise of nursing staff, 3) the type of services provided, 4) the standard used at like tertiary hospitals, and 5) budget constraints related to funding levels.

The standard varies to some degree, depending on the patient care unit and inherent differences in normal workload. The range in the study hospital is from 3.5 to 4.8 hours of nursing care for the average patient. For the purpose of this study two standards are used. They were selected on the basis of discussions with nursing management.

Type 1, II and III patients = 3.5 hours
Type IV and V patients = 4.5 hours

The actual hours of care required for each patient in a 24 hour period are calculated in the following manner.

Patient Type	X	Coefficient	X	Standard	=	Hours of Care
I		.5		3.5	=	1.75 hours
II		1.0		3.5	=	3.5 hours
III		2.5		3.5	=	8.75 hours
IV		5.0		4.5	=	22.5 hours
V		10.0		4.5	=	45.0 hours

A type IV patient requires constant care while the staff to patient ratio for a type V patient is 2:1.

Reliability

An ongoing program of reliability testing is in place at the hospital, which consists of a random check of one third of all patient care units monthly. A neutral "expert" classifies 15 percent of all (randomly selected) patients on each unit, and compares her rating with that done by the unit supervisor or charge nurse. Any unit which does not achieve 95 percent inter-rater reliability is monitored monthly until that goal is reached, at which time checks every third month are instituted. As an extra reliability check, quality assurance monitors compare their classification with that of unit supervisors when performing audit functions. It is assumed that inter-rater reliability levels are adequate and no independent reliability check was undertaken for this study. The average interrater agreement at the hospital for the period of study was 95.4 percent, with a range of 89.5 to 100 percent per month.

3.5 Costing Nursing Services

In this section the approach used to allocate nursing costs is outlined. It is first of all necessary to distinguish between direct and indirect nursing care.

1. Direct nursing care: Direct care is the daily care provided to patients by all nursing staff, including assistant unit supervisors, charge nurses, registered nurses and nursing assistants. It includes all activities provided in support of patients, such as preparation, clean-up time and patient transport. Direct care is

computed from daily classification forms, which provide for each patient in the sample an estimate of the amount of nursing care required for each day of stay. Direct care is that portion of the nursing department's activities which varies with patient volume and patient type.

2. Indirect care: This is defined as that portion of the nursing department's activities not accounted for by daily patient classification. It includes activities such as nursing administration, unit management (supervisors and ward clerks), nursing research and nursing in-service education. Indirect care is that portion of the nursing department's activities which is not expected to fluctuate with patient volume or patient type.

On this basis, variable and fixed costs are allocated to specific DRGs in the following manner.

1. Variable costs: For each patient and for each day of stay, hours of care derived from the patient classification form (section 3.4.2) are converted to a nursing labour cost calculated on the basis of the average hourly nursing wage ($14.53) at the study hospital. This wage describes a Level 4 Registered Nurse with about 4 years of related experience. Because of its role as a tertiary care facility, the hospital recruits primarily experienced professional nurses, and few, if any, non-professional nursing staff (eg. RNA). The wage figure used in this study is that provided by nursing management. An efficiency factor is added, to account for non-productive hours,

vacation and illness benefits, shift differentials and vacation pay for part-time nurses. The efficiency factor is that used by the hospital's accounting system (1.15). It is multiplied by the average hourly wage to estimate total nursing direct labour costs.

Average Wage	X	Efficiency Factor	=	Direct cost
\$14.53	X	1.15	=	\$16.71

For ease of calculation, the figure is rounded to \$17.00. Although this will ultimately inflate the actual costs of providing nursing care for this sample population, it will not influence the outcome of the study since all patients are equally affected. The purpose of this study is not to allocate the full costs of this hospital's nursing department but rather to study the differential behaviour of costs according to case mix.

The variable cost is uniform per hour of care for all patients, but the total nursing cost per patient fluctuates in direct proportion to the number of nursing care hours received during the episode of illness (Horngren, 1981).

2. Fixed costs: The fixed costs allocated to each DRG include wages for unit management, nursing research, in-service and administration personnel. Total fixed costs do not change with patient volume, but become progressively smaller per patient as volume increases (Horngren, 1981). Hospital cost accounting in Canada does not facilitate extricating fixed from total operating costs. Research

has shown, however, that direct nursing care accounts for about 60 percent of a nursing department's total cost (Riley & Schaefers, 1983). Davies and Westfall (1983) also found that indirect services represent about 40 percent of a patient's total costs. For this research, 40 percent of the nursing department's total costs for fiscal 1983-84 were allocated as fixed costs, divided by the number of patient days for the same period. A fixed cost of $54.00 per patient day was derived. Fixed costs per case are length of stay dependent. Because of the expected linear relationship between length of stay and complexity, it is essential to allocate fixed costs to obtain a true picture of the behavior of nursing costs at different complexity levels. The actual dollar value used is of little consequence, since it applies equally to all patients for each day of stay.

Direct and total *nursing* costs for each patient type per day of stay are as follows:

TABLE 3 DIRECT AND TOTAL NURSING COSTS

Pt Type	Hours of Care	Direct Costs	Total Costs
I	1.75	29.75	83.75
II	3.5	59.50	113.50
III	8.75	148.75	202.75
IV	22.5	382.50	436.50
V	45.0	765.00	819.00

3.6 Data Analysis Strategies

Data analysis is carried out in two phases. Descriptive statistical procedures are used to assess the amount of variability in nursing costs which exists within and among DRGs. Analysis of variance is then carried out to test several hypotheses.

3.6.1 Descriptive Analysis

For each patient, length of stay, cost per day and cost per stay are calculated using the Statistical Analysis Systems (SAS) computer package. The data set is then summarized using measures of central tendency and dispersion as follows.

Range: For each DRG the range of costs is analyzed with particular attention given to length of stay. Outliers are identified and excluded from the data set, since they are atypically expensive for their DRG category, and exert an inappropriate influence on the group mean cost. There are significant differences in overall average lengths of stay in Canadian and American hospitals (Glaser, 1980). Outlier cut-off points in the DRG and CMG systems are, not surprisingly, also quite different.

In the DRG system, an outlier is defined as a case which exceeds the geometric mean length of stay by 20 days or 1.95 standard deviations, whichever is less (A.H.A., 1983). The HMRI system defines an outlier as a long stay case which exceeds the average length of stay by three standard deviations (HMRI, 1984). Since the setting for this study is a

Canadian tertiary care centre, the HMRI trim point is used to exclude outliers. For comparative purposes, the average lengths of stay and trim points for the two systems are summarized in Table 4.

TABLE 4 MEAN LOS AND TRIM POINTS--DRGs AND CMGs

		DRG		CMG	
DRG	CMG	ALOS	TRIM PT.	ALOS	TRIM PT.
# 001	# 001	19.4 days	39 days	23.7 days	140 days
088	113	7.5	28	10.7	58
105	140	16.2	36	16.2	51
107	142	13.5	34	13.0	36
122	157	9.8	30	12.5	40
148	193	17.0	37	22.7	94
162	207	4.8	12	4.2	9
209	274	17.1	37	22.3	101
222	287	6.4	26	4.2	17
335	445	11.8	29	16.1	46
355	475	8.8	17	7.9	16
430	595	10.8	31	20.4	115
458	643	18.3	38	23.8	98

The mean cost for each DRG category is computed for the trimmed data set, and the extent of variability in costs is described using the Coefficient of Variation (C.V.) statistic. This is derived by dividing the standard deviation within a group by the mean. The larger the C.V., the more *heterogeneous* the data (Giovannetti et al, 1984; Horn, Sharkey & Bertram, 1983).

Developing a measure of complexity: To form complexity subgroups, the median classification type for each patient is determined, and used to typify that patient's nursing resource utilization throughout his hospital stay. The median, rather than the mean, is felt to be the most appropriate measure of central tendency for this purpose, given the expected skewed distribution of classification scores for each day of hospitalization (Phillips & Thompson, 1967). Elective admissions are characterized by low intensity of nursing need at the beginning and end of hospitalization, with higher intensity peaking in mid-course. Urgent admissions, deaths and transfers to other acute care facilities on the other hand are expected to have quite different demands for nursing resources during the course of their hospital stay (Caterinicchio & Davies, 1983).

Five DRG specific subgroups are formed using the classification patient types. The C.V. statistic is again computed to assess their degree of homogeneity with respect to nursing costs (Horn, 1983; Kreitzer et al, 1982).

3.6.2 Hypothesis Testing

The hypotheses outlined in Section 1.6 are tested using analysis of variance techniques. The rationale behind the hypotheses and the expected results are described below. Hypotheses are described in both the null (Ho) and alternate (Ha) forms.

1. Hypothesis #1

Ho: There are no mean differences in nursing costs among DRGs.

Ha: There are mean differences in nursing costs among DRGs which are not attributable to random fluctuation.

The CLASSIFY algorithm used to form the 467 DRG categories places more importance on group means than on their variances (Williams et al, 1984). Since DRGs are defined on the basis of similarities in resource consumption within categories, significant differences in mean costs across DRGs are expected, assuming that nursing resource use and total hospital resource consumption are related.

The hypothesis is tested using one-way ANOVA. The data are arranged as follows.

	DRG (Independent Variable)											
	001	088	105	107	122	148	162	209	222	335	355	430
MEAN COST (Dependent Var)	$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_3$	$\bar{x}_4$	$\bar{x}_5$	$\bar{x}_6$	$\bar{x}_7$	$\bar{x}_8$	$\bar{x}_9$	$\bar{x}_{10}$	$\bar{x}_{11}$	$\bar{x}_{12}$

One-way analysis of variance is used to determine whether mean differences among the DRGs are due to random fluctuation or to true differences in costs.

Under the null hypothesis that the means of the twelve DRGs are equal, random sampling would cause variation of scores within each group due to sampling error alone. In one-way analysis of variance, variability within the group is designated variance due to error. The sums of squares (SS) which are calculated are:

Total SS = SS within (error) + SS between (across DRGs). SS between is also referred to as SS due to the model, and Total SS is often labelled the total corrected for the mean.

The F statistic, distributed with (K-1) and (N-K) degrees of freedom (where K = # DRG groups) provides the basis for testing the hypothesis.

$$F = \frac{\text{SS between/df between}}{\text{SS error/df error}} \qquad (\text{df}=11)$$

The larger the F test, the greater is the difference which exists among the mean costs of the DRGs (Hunka & Maguire, 1982). The decision rule for assessing the null hypothesis is (Pagano, 1983, p. 200)

if the obtained probability $\leq$ .05, reject Ho
if the obtained probability $\geq$ .05, fail to reject Ho

The same decision rule applies for all significance tests.

Pagano (1981, p. 371) observes that the assumptions underlying the analysis of variance are:

1. The populations from which the samples are drawn are normally distributed.

2. There is homogeneity of variance among the populations from which the samples are drawn.

The last point is particularly important when the samples are of unequal size, as in this case. There is no reason to believe either assumption is violated in this study.

In this study data are analyzed using the SAS General Linear Model (PROC GLM) framework, since the sample size of diagnostic categories and complexity subgroups is uneven across and within DRGs.

2. Hypothesis #2

#2 Ho: There is no mean difference in costs among subgroups within each DRG.

Ha: There is significant mean difference in costs within DRGs partitioned into subgroups.

If the complexity index (derived from each patient's median classification score) is successful in differentiating groups of patients with varying levels of dependency on the nursing staff, the mean costs of subgroups should be significantly different. This hypothesis will also be tested using one-way ANOVA for each of the twelve DRGs separately.

3. Hypothesis #3

#3 Ho: There is no mean difference in nursing costs across DRGs when complexity level is held constant.

Ha: There is a mean difference in nursing costs across DRGs within the complexity levels.

An important issue addressed in this research is whether or not there are substantial benefits to be derived from analyzing nursing costs on the basis of case mix. Many hospitals now use nursing classification systems to measure patient needs on a day to day basis. If stay specific nursing costs for each complexity level are similar across the diagnostic categories, the time and expense required to further analyze costs by DRG may not be worthwhile. If there are significant differences among the mean costs of nursing across diagnoses within complexity levels, then important information can be gained through case mix cost analysis. The questions to be asked of the data are:

1. Are there significant differences among the means for Subgroup 1?

2. Are there significant differences among the means for Subgroup 2?

3. Are there significant differences among the means for Subgroup 3?

4. Are there significant differences among the means for Subgroup 4?

The hypothesis is tested using one-way ANOVA for each of the complexity subgroups. Only one DRG (#148) contained a patient who was typed at level 5. The DRG also had only one type 4 patient. These two cases are combined in level 4 for data analysis.

The ANOVA procedures are applied to testing the influences of age, type of admission and condition at discharge using the same format as described for the complexity subgroups.

4. DATA ANALYSIS

The results of data analysis are presented in two phases. The first section of this chapter deals with a descriptive analysis of the study results. This is followed by a discussion of the statistical procedures used to assess the significance of the findings.

4.1 Descriptive Analysis

The original patient sample was comprised of 1,434 individuals, and represented approximately nine percent of the total patient population discharged from the study hospital in the six month period October, 1983 to March, 1984.

As a first step in data analysis, lengths of stay were reviewed and outliers (i.e. long stay cases which exceeded the trim points defined by the Hospital Medical Records Institute - HMRI) were excluded from the sample. Table 5 depicts the total nursing cost and length of stay (LOS) ranges of the original sample, the HMRI trim points, and the resultant sample size for each Diagnosis Related Group (DRG).

TABLE 5 RANGE OF TOTAL NURSING COSTS & LENGTHS OF STAY BY DRG

DRG	Cost Range (in $)	LOS Range (in days)	HMRI Trim Point	Exclusions	New N
001	316.25 - 32,007.50	2 - 126	140	0	89
088	227.00 - 62,201.55	2 - 314	58	4	106
105	663.50 - 44,600.00	3 - 105	51	4	63
107	1,302.80 - 26,001.30	4 - 92	36	3	128
122	202.75 - 5,571.00	1 - 41	40	1	85
148	1,013.80 - 47,559.50	5 - 199	94	2	68
162	286.50 - 2,059.50	2 - 15	9	4	80
209	429.75 - 38,447.50	3 - 182	101	1	137
222	113.50 - 8,515.50	1 - 51	17	3	219
335	616.00 - 4,372.50	6 - 41	46	0	115
355	597.25 - 3,810.50	5 - 32	16	7	151
430	316.30 - 26,760.80	2 - 127	115	1	130
458	1,762.00 - 75,063.30	14 - 126	98	1	32

The exclusion of 31 outliers (2.2% of the sample) reduced the total nursing costs for the study sample from $3,608,178.05 to $3,109,720.50, a 16 percent decrease.

A concomittant 11 percent decrease was realized in patient days, which were reduced from 21,021 to 18,963 days. Although outliers appear to represent an insignificant portion of discharges in the selected diagnostic categories, they contribute disproportionately to the total costs of the nursing department.

The study results discussed hereafter deal with the 1,403 patients remaining in the sample after the exclusion process.

4.1.1 Total and Direct Costs of Nursing by DRG

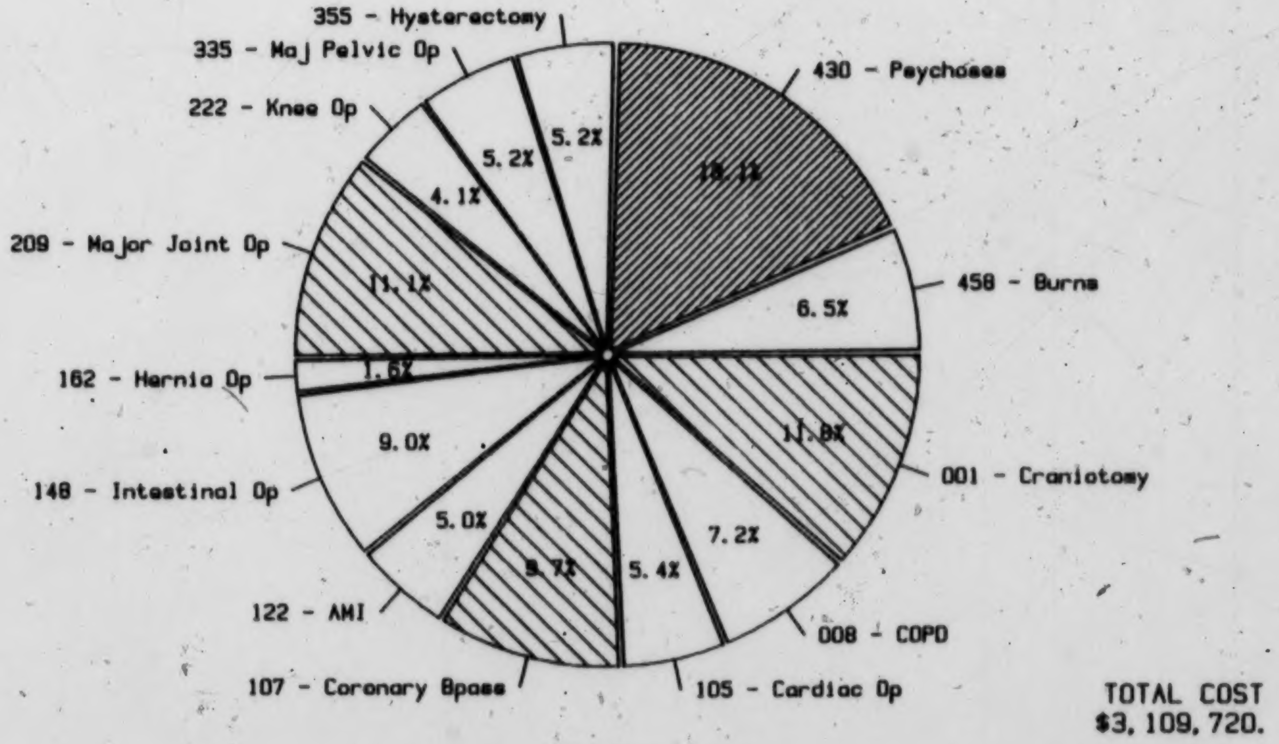
Total and direct nursing costs and associated cost ranges for each DRG are presented in Table 6. The lowest total cost is associated with a one-day (i.e. overnight) stay in DRG #222, knee operation without complication or comorbidity. The highest cost, found in DRG #001, Craniotomy without trauma, was incurred by a long stay patient who was hospitalized for 115 days. The difference between direct and total nursing costs is largely length of stay dependent. The two costs are given for comparative purposes.

TABLE 6 TOTAL AND DIRECT NURSING COSTS AND RANGES BY DRG

DRG	Total Costs	Cost Range	Direct Costs	Cost Range
001	368,189.00	316.25 - 32,007.50	264,401.00	119.00 - 25,797.50
088	222,955.25	227.00 - 10,478.00	142,549.25	119.00 - 7,616.00
105	168,017.00	663.50 - 7,198.00	122,927.00	501.50 - 5,848.00
107	302,064.50	1,302.80 - 7,383.00	220,362.50	862.75 - 6,188.00
122	156,243.50	202.75 - 5,571.00	104,133.50	119.00 - 4,437.00
148	280,656.25	1,013.75 - 16,084.50	197,442.25	743.75 - 11,602.50
162	50,845.50	286.50 - 1,127.25	28,381.50	178.50 - 803.25
209	344,686.50	429.75 - 16,671.00	221,620.50	267.75 - 12,189.00
222	127,802.25	113.50 - 1,946.00	78,986.25	59.50 - 1,190.00
335	160,849.75	616.00 - 4,372.50	83,737.75	238.00 - 3,238.50
355	161,158.00	597.25 - 2,208.25	91,120.00	327.25 - 1,398.25
430	563,918.25	316.25 - 15,966.50	375,296.25	208.25 - 13,663.80
458	202,334.75	1,762.00 - 26,863.80	154,814.75	952.00 - 23,353.80
TOT.	3,109,720.50	113.50 - 32,007.50	2,085,772.50	59.50 - 25,797.50

The four costliest diagnoses are Psychoses (#430), Craniotomy (#001), Major Joint operation (#209) and Coronary Bypass (#107). The proportional contribution of each DRG to the total nursing costs in this sample is represented graphically in figure 1, (page 104). In order of costliness,

Proportion of Total Nursing Costs
by DRG



TOTAL COST
$3,109,720.

Figure 1

the "medical" DRGs (#430, #088, #122) rank first, sixth and ninth, respectively. The two "sex-differentiated" DRGs (#335 and #355) provide an equal share of the costs.

Figure 2 (p. 106) depicts the proportional sample size of each DRG relative to the total sample. The four highest volume DRGs are, in decreasing order, Knee operation (#222), Hysterectomy (#355), Major joint operation (#209) and Psychoses (#430). The first and second costliest DRGs (#430 and #001) rank fourth and eighth respectively in terms of population size, while Burns (#458) which is seventh in terms of cost has by far the smallest proportion of the total population (2.3%). These data suggest that an increase in the number of admissions for Burns, Psychoses, and Craniotomy would have a far greater impact on the nursing department's costs than would volume increases in any of the other DRGs included in this study, since patient for patient, these three diagnoses are twice to three times as costly as the others.

4.1.2 Mean Costs of Nursing

Average nursing costs, both direct and total, are summarized in Table 7 (p. 107). Costliness weights, defined as the ratio of the DRG specific mean nursing cost to the overall mean nursing cost, are given and each DRG is ranked in terms of its per capita contribution to the nursing department's costs. DRG weights are listed for comparative purposes. The latter represent the costliness of each diagnostic category relative to the total group of 467 DRGs, and as such they are not comparable to

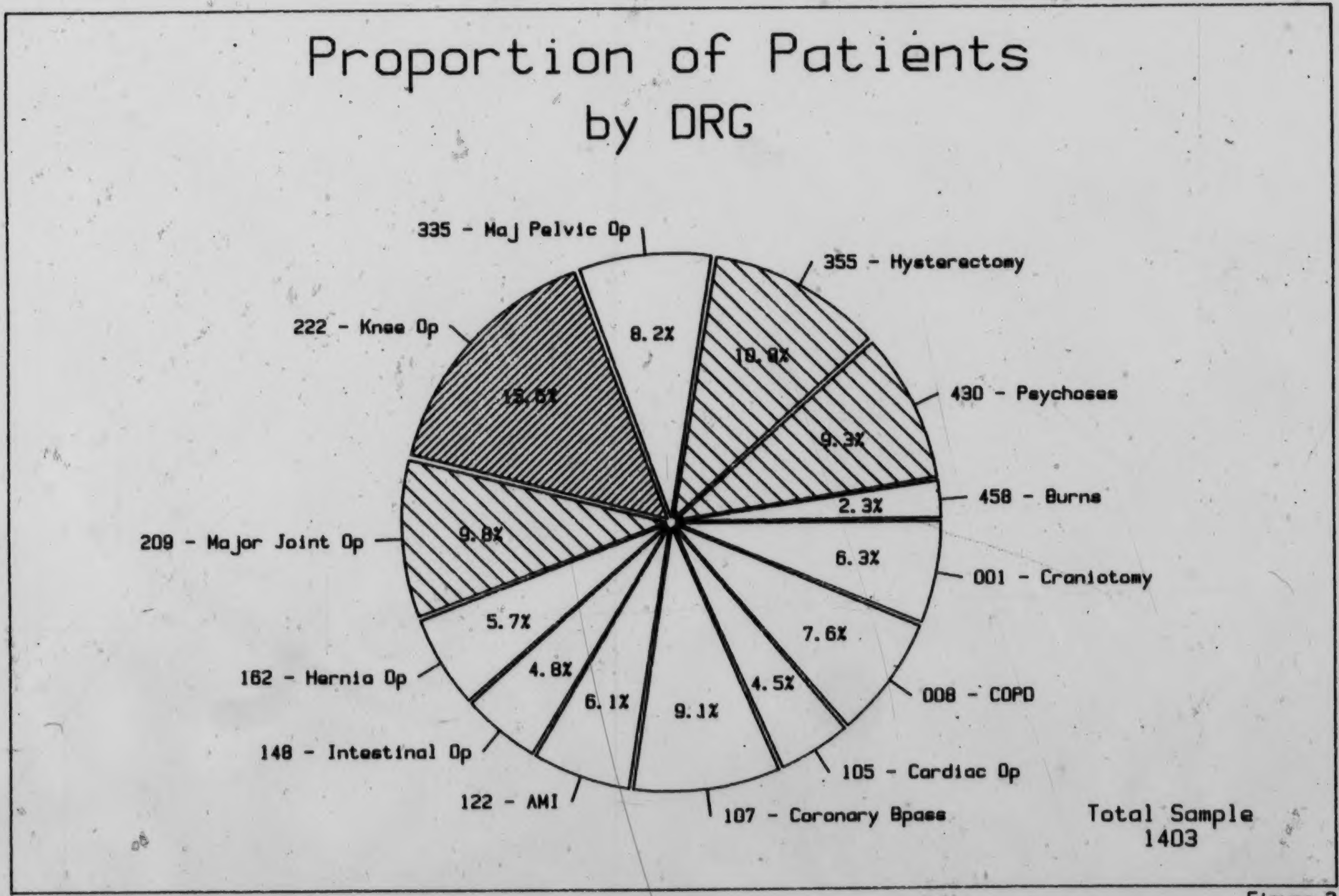

Proportion of Patients
by DRG
335 - Maj Pelvic Op
8.2%
355 - Hysterectomy
10.8%
430 - Psychoses
9.3%
458 - Burns
2.3%
001 - Craniotomy
6.3%
008 - COPD
7.6%
105 - Cardiac Op
4.5%
107 - Coronary Bpass
9.1%
122 - AMI
6.1%
148 - Intestinal Op
4.8%
162 - Hernia Op
5.7%
209 - Major Joint Op
9.8%
222 - Knee Op
15.5%
Total Sample
1403

Figure 2

the nursing costliness weights derived for the DRGs selected in this study. Each DRG is nonetheless ranked to demonstrate which represents the greatest use of total hospital resources among the thirteen diagnostic groups included. It is important to reiterate that the DRG rank calculated for this study does not in any way relate to the order of costliness of that DRG relative to the other 454 DRGs in the DRG classification system.

TABLE 7 MEAN COSTS* AND RELATIVE COSTLINESS OF SELECTED DRGs

		Total Nursing Costs			Direct Nursing Costs			DRGS	
DRG	Title	(in $)	Weight	Rank	(in $)	Weight	Rank	Weight	Rank
001	Craniotomy	4,137	1.950	3	2,971	2.110	2	3.3548	3
088	COPD	2,103	.992	8	1,345	.955	8	1.0412	10
105	Cardiac Op	2,667	1.257	5	1,951	1.386	5	5.2308	1
107	Coronary Bypass	2,360	1.113	7	1,722	1.223	6	3.9891	2
122	AMI	1,838	.867	9	1,224	.869	9	1.3651	7
148	Intestinal Op	4,127	1.946	4	2,904	2.063	3	2.5493	5
162	Hernia Op	636	.300	12	355	.252	13	.5854	13
209	Joint Op	2,516	1.186	6	1,618	1.149	7	2.2912	6
222	Knee Op	584	.275	13	361	.256	12	.9897	12
335	Pelvic Op, Male	1,399	.660	10	728	.517	10	1.3590	8
355	Hysterectomy	1,067	.503	11	603	.428	11	1.0156	11
430	Psychoses	4,338	2.045	2	2,887	2.050	4	1.0934	9
458	Burns	6,323	2.981	1	4,838	3.436	1	2.8572	4
Sample Mean		2,121			1,408				

* Rounded to whole integers.

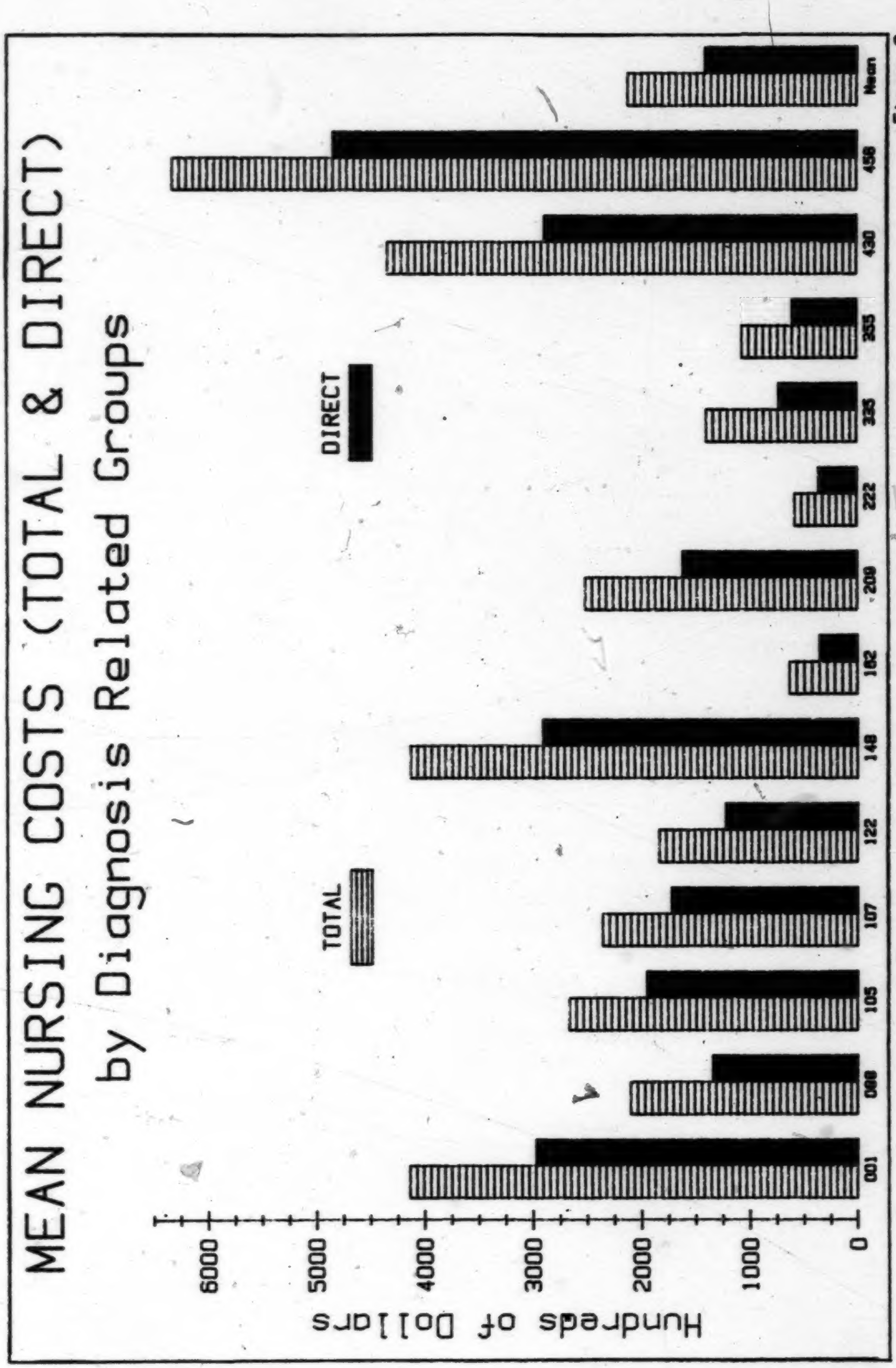
Burns (#458) is associated with the highest total nursing cost per case, followed by Psychoses (#430), Craniotomy (#001), and Major Intestinal operation with complications, comorbidity or age >70 years (#148). The order of costliness is somewhat different for direct nursing costs. Burns maintains its first position, but Psychoses moves to fourth place, preceded by Craniotomy and Major Intestinal operation, respectively. The order of costliness of the other DRGs differs only slightly when a comparison is made between total and direct nursing costs.

Total nursing costs include the direct daily costs of care in addition to a fixed cost which is allocated even if the patient is out on pass and receives no nursing care. The direct costs of nursing care therefore more accurately reflect the use of nursing resources related to illness acuity and other patient specific attributes (eg. age). The data presented in table 7 suggest that patients admitted with Psychoses may have longer lengths of stay, but consume overall fewer nursing resources than patients with Burns, Craniotomy or Major Intestinal surgery.

The costliness weights calculated for this sample represent the relative complexity of diagnoses with regard to total use of *nursing* resources, and the DRG weights represent relative consumption of *hospital* resources, including ancillary services. While no direct comparison can be made between the weights, it is interesting that of the top five hospital resource intensive DRGs included in this study, four are also among the most complex in terms of nursing resource use. The order of importance is, however, quite different. Cardiac Valve Surgery (#105) and Coronary Bypass (#107) have the two highest weights of the DRGs in this study but only one (#105) is among the five most nursing intensive DRGs, and is ranked in last place. This suggests that DRGs #105 and #107 consume proportionately more ancillary than nursing resources per case. The diagnostic group Psychoses (#430), on the other hand, is relatively complex in nursing terms but place a much lesser burden on the hospital's total resources.

An increase in the volume of patients admitted for Burns (#458), Craniotomy (#001), Major Intestinal Op (#148), Psychoses (#430) and Cardiac Valve Op (#105) in that order would have the greatest impact on the nursing department's budget (of the DRGs included in this study), since they are associated with the highest direct nursing costs per case.

Figure 3 (p. 110) depicts the mean nursing costs, total and direct, for each DRG and for the overall sample. In addition to the five costliest DRGs mentioned above, it can be seen that DRGs #107 (Coronary Bypass) and #209 (Major Joint Op) exceed the group mean cost. DRGs #162 (Femoral/ Inguinal Hernia Op) and #222 (Knee Op) are associated with the lowest nursing costs per case.



MEAN NURSING COSTS (TOTAL & DIRECT)
by Diagnosis Related Groups

Figure 3

4.1.3 Patient Days and Lengths of Stay

The DRG patient classification system was designed using length of stay (LOS) as a primary variable in creating groups of patients which differed substantially with respect to total patient charges. Hence it is expected that the DRGs in this study will vary in terms of length of stay across diagnostic groups, but will be fairly homogeneous within. Nonetheless, if patients can be differentiated on the basis of varying levels of complexity of nursing care, there should be some variance in length of stay within diagnostic groups, assuming that a positive and linear relationship exists between length of stay and complexity. By assigning a fixed cost per day of stay ($54.00) the mean total cost of nursing care is weighted by the increased length of stay at higher complexity levels, allowing maximum discrimination between the complexity groups, both within and across diagnostic categories. The mean cost of direct nursing care should follow the same pattern if complexity and length of stay are related, but would be expected to better differentiate between levels of complexity if there are no substantial differences in length of stay within diagnostic categories, since it reflects only actual use of nursing resources and is somewhat less length of stay dependent.

Table 8 lists total patient days, length of stay ranges and average lengths of stay (LOS) for each of the DRGs. The average lengths of stay experienced in HMRI member hospitals are also given for comparative purposes.

TABLE 8 PATIENT DAYS, LOS RANGE, AVERAGE LOS AND TOTAL NURSING COST PER PATIENT DAY

DRG	N	Pt. Days	LOS Range (in days)	Average LOS	HMRI LOS	Per Diem Nursing Cost (Total)
001	89	1,922	2 - 126	21.6 days	23.7	180.18
088	106	1,489	2 - 53	14.1	10.7	149.45
105	63	835	3 - 43	13.3	16.2	207.97
107	128	1,513	4 - 30	11.8	13.0	201.55
122	85	965	1 - 33	11.4	12.5	157.84
148	68	1,541	5 - 83	22.7	22.7	188.94
162	80	416	2 - 9	5.2	4.2	124.85
209	137	2,279	3 - 83	16.6	22.3	151.37
222	219	904	1 - 17	4.1	4.2	145.51
335	115	1,428	6 - 41	12.4	16.1	111.89
355	151	1,297	5 - 51	8.6	7.9	124.73
430	130	3,494	2 - 113	26.9	20.4	163.75
458	32	880	14 - 65	27.5	23.8	209.72
Sample	1,403	18,963		13.5		163.99

Burns (#458), Psychoses (#430), Major Intestinal Op (#148) and Craniotomy (#001) are associated with the four longest average stays, respectively. These same DRGs also have the highest nursing costs per case, which is not surprising. This table demonstrates that the second and third highest nursing costs per patient day are incurred by patients in DRGs #105 (Cardiac Valve Op) and #107 (Coronary Bypass), while Craniotomy (#001), Major Intestinal Op (#148) and Psychoses (#430) are relegated to the fourth, fifth and sixth positions respectively.

A comparison between the study hospital and the HMRI average lengths of stay warrants some comment. The HMRI length of stay data summarize the experience of all its member hospitals. These include, but are not limited to, hospitals of similar size and scope as that of the study hospital.

The study hospital exceeds the average length of stay of HMRI hospitals in five diagnostic groups - #458 (Burns), #430 (Psychoses), #355 (Hysterectomy), #162 (Femoral/Inguinal Hernia) and #088 (COPD). Of these, the latter three are fairly common diagnoses which would likely be included in the case mix of most community hospitals. One can speculate that the greater lengths of stay recorded in this institution are an indication that the cases treated are more complex than average. The Burn Unit in the hospital is a highly specialized referral centre for all major burn cases in the northern half of the province. There is little doubt that its higher than average LOS is at least in part associated with a high degree of case complexity.

Among some other diagnoses which would likely be found only in tertiary care centres (e.g #105, #107, #148, #209) the study hospital fares well relative to the HMRI average LOS. One can again conjecture that this institution is at least as efficient as (if not more than) others of similar size and role. These assumptions, however, could only be validated through further study, which is not the subject of this research.

Table 8 demonstrates that, as expected, average lengths of stay are substantially different across diagnoses. Variance within diagnostic groups is described in a following section.

4.1.4 Forming Complexity Subgroups

A major objective of this research was to analyze the interrelationship between diagnosis and complexity of nursing care (i.e. nursing resource use). The measure of complexity is the patient's level of intensity (or nursing care need) on each day of stay, summarized to typify stay specific resource consumption. One of two measures of central tendency could be used in forming the complexity index - the arithmetic mean or the median. The mean is the better measure of central tendency when the distribution of scores is symmetrical, but is considered inappropriate for skewed distributions (Phillips & Thompson, 1967, p. 72). To determine which of the measures would be most suitable for this research, the Statistical Analysis Systems (SAS) computer package was used to calculate the arithmetic mean and the median classification scores for each patient in the sample. In both calculations, decimals were rounded to the nearest whole integer by increasing the preceding digit by one if the decimal fraction was $\geq .5$. The subgroup sample size by DRG for each calculation is presented in Table 9. As can be seen, the majority of cases are clustered in complexity levels 2 and 3. There are relatively few cases in level 4 and only one DRG (#148) has a case in level 5. The number of patients in level 1 is highly variable across DRGs.

TABLE 9 DRG SUBGROUP SIZE USING MEAN AND MEDIAN SCORES

Sub Group	001	088	105	107	122	148	162	209	222	335	355	430	458
1 Mean	9	15	1		-		3		1	54	5	7	-
Median	24	18	1		1		18		1	79	73	14	1
2 Mean	49	46	14	32	48	27	73	105	139	59	144	86	8
Median	29	40	33	83	46	16	57	104	137	32	75	62	8
3 Mean	24	42	47	95	37	39	4	29	79	2	2	33	22
Median	29	45	28	42	38	50	5	30	81	4	3	50	21
4 Mean	7	3	1	1		1		3				4	2
Median	7	3	1	3		1		3				4	2
5 Mean						1							
Median						1							

The choice of mean or median has very little effect on complexity levels 4 or 5, but causes a substantially different subgroup sample size in some DRGs, particularly #001 (Craniotomy - levels 1 and 2), #105 (Cardiac Valve Op - levels 2 and 3), #107 (Coronary Bypass, levels 2 and 3) #148 (Intestinal Op - levels 2 and 3), #162 (Hernia Op, levels 1 and 2), and #335 and #355 (levels 1 and 2). There is, however, no consistent relationship. In some cases, use of the median increases the proportion of patients in one level while in other instances it reduces the number in that level. Overall, using the median increases the number of cases in level 1 from 95 to 230, while it decreases the number in level 2 from 830 to 722, and in level 3 from 455 to 426.

DRGs #088 (COPD), #148 (Intestinal Op) and #458 (Burns) have proportionately more patients in complexity subgroup 3 than in any of the other levels, while DRG #001 has the same proportion in levels 2 and 3. On the other hand, the majority of patients in DRG #335 (Male Pelvic Op) appear to be below average in terms of their relative demand for nursing resources.

The distribution of daily classification scores among patients is of course highly skewed since it varies with length of stay. As an example, the daily classification scores and the median and mean scores for two patients in DRG #001 are given.

Daily Classification	LOS	Mean Score	Median Score
3 4 3 3 2 2 1 2 2 3 4 4 4 4 3 3 2 3 3 3 2 2	25 days	3	3
2 2 2 4 3 1 1 1 1 1 1	11 days	2	1

Given differences in lengths of stay both within and across DRGS, which increases the skewness of the distribution of scores among the diagnostic groups, the median was felt to be the better measure of central tendency to use in forming the complexity levels. Its overall effect is to reduce the level of complexity for the sample as a whole, but since it is not as directly tied with length of stay, it perhaps best reflects the actual use of direct nursing services.

4.1.5 Analysis of Mean Costs by Complexity Level

Once complexity subgroups were formed, the mean costs of each subgroup were calculated using SAS. The amount of variability in nursing costs was estimated for each DRG and its complexity subgroups using the coefficient of variation (C.V.) statistic, derived by dividing the standard deviation by the appropriate group mean.

> The coefficient of variation measures the relative homogeneity of a sample and permits comparison of amounts of variation among samples with different means and standard deviations. As a rule of thumb, groups with ratios below 0.10 are regarded as reasonably homogeneous (Giovannetti, Edwardson and Busch, 1984, p. 5).

Measuring Variability

The C.V. for the DRG group as a whole and for each subgroup is substantially greater than 0.10 for all diagnostic categories included in this study. This indicates that there is a great deal of variation in terms of nursing resource use within diagnostic categories, even after patients have been assigned to a "representative" complexity level. A detailed summary of group means and their respective CVs is provided in Appendix D (p. 206) for total, direct and per diem nursing costs. All DRGs except #107 (Coronary Bypass), #162 (Hernia Op) and #355 (Hysterectomy) have C.V.s greater than 0.5 when mean total and direct nursing costs are considered.

It is interesting to note that in almost all instances the CV is slightly larger for direct, as opposed to total, nursing costs (pp. 207-209). This is most pronounced in DRGs #001 (Craniotomy), #088 (COPD), #458 (Burns), #209 (Major Joint Op), #335 (Male Pelvic Op), and #430 (Psychoses). Most of these diagnoses are among the DRGs with the longest average lengths of stay, and with the greatest amount of variability in length of stay among the subgroups (p. 211). The difference in degree of variability between direct and total costs remains even when length of stay is held constant by analyzing costs on a per diem basis, but the actual amount of variability within each of the subgroups is substantially reduced, particularly with respect to total costs (p. 208). This implies that the allocation of fixed nursing costs tends to mask true differences in the consumption of direct nursing resources, even among patients assigned to the same complexity level.

The marked reduction in the size of the CV when length of stay is controlled for suggests that a great deal of variability in nursing costs (i.e. in complexity) is due to variability in length of stay. This establishes a spurious relationship between complexity and length of stay if the latter is a function of misutilization of the hospital facility.

The substantive degree of heterogeneity in consumption of direct nursing services (found in all DRGs except #355) is an indication that significant fluctuation exists in the intensity of nursing care needed on a day to day basis, even among patients whose overall level of complexity throughout the course of hospitalization is similar.

Mean Total and Direct Nursing Cost Comparisons

It was suggested (Section 4.1.3, p. 111) that the mean *total* costs of nursing should vary substantially across complexity levels within diagnostic categories if a positive and linear relationship exists between length of stay and complexity. Although a logical ordering of mean costs was found to occur with successive increases in complexity level for the majority of DRGs, the expected relationship did not hold for DRGs #001, #105, #148, #162, and #222. When just the *direct* costs of nursing were considered, only DRGs #105 (Cardiac Valve Op) and #222 (Knee Op) failed to conform as expected. This is depicted graphically in Figures 4 through 8 on the following five pages. As previously indicated this suggests substantial homogeneity in length of stay patterns across the complexity subgroups.

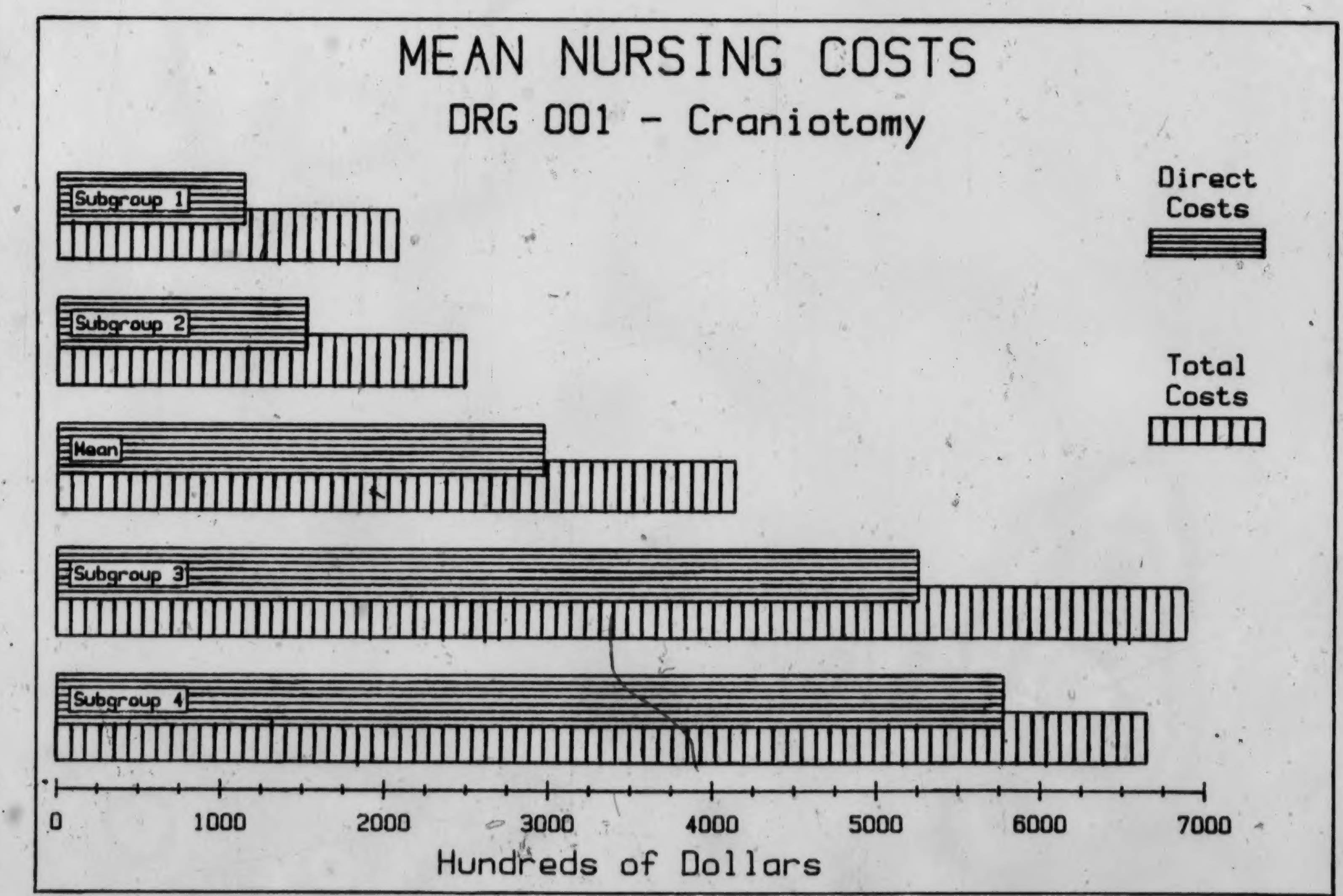

MEAN NURSING COSTS
DRG 001 - Craniotomy
Direct Costs
Total Costs
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Subgroup 4
0
1000
2000
3000
4000
5000
6000
7000
Hundreds of Dollars

Figure 4

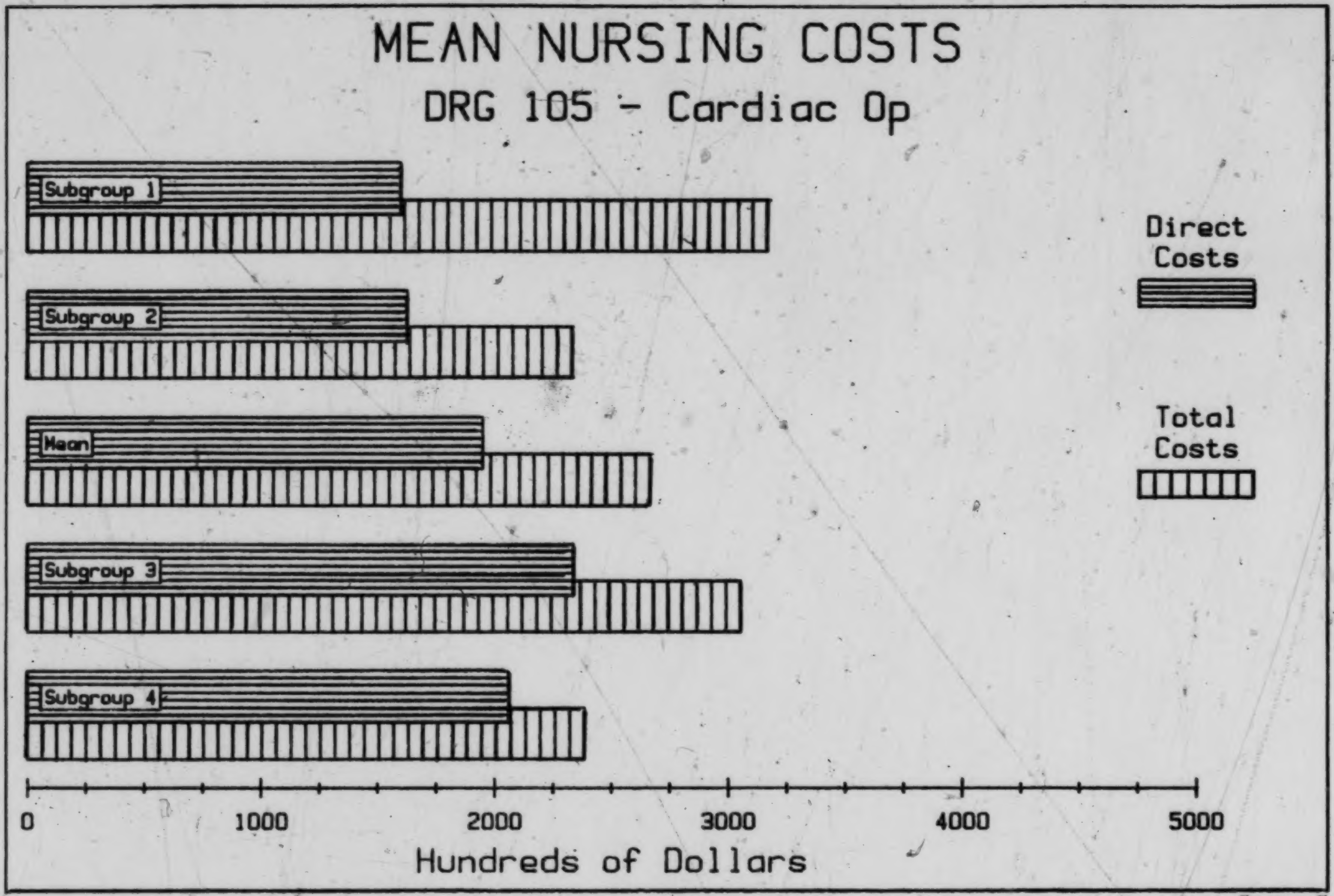

MEAN NURSING COSTS
DRG 105 - Cardiac Op
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Subgroup 4
Direct Costs
Total Costs
0
1000
2000
3000
4000
5000
Hundreds of Dollars

Figure 5

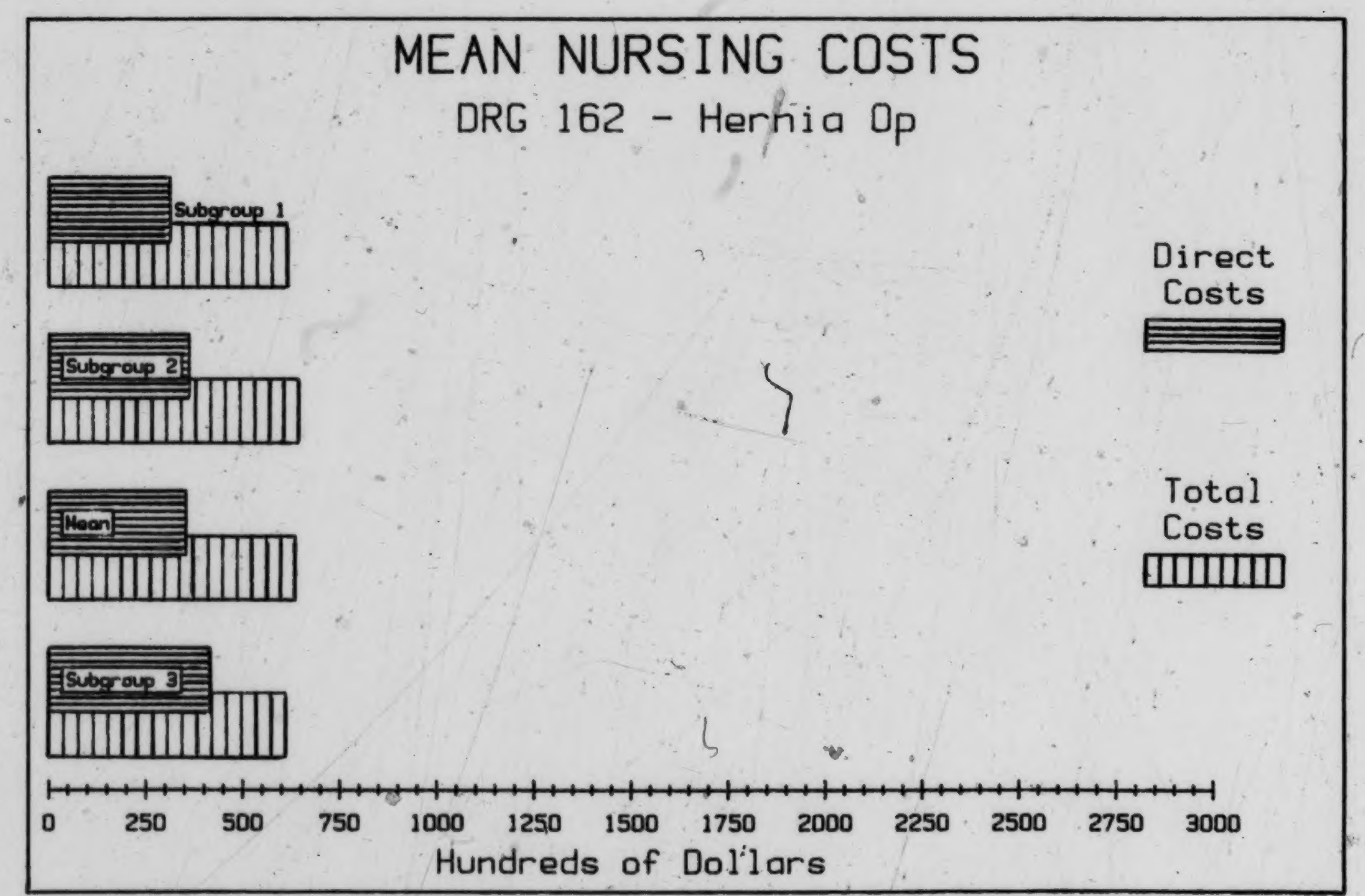

MEAN NURSING COSTS
DRG 162 - Hernia Op
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Direct Costs
Total Costs
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
Hundreds of Dollars

Figure 6

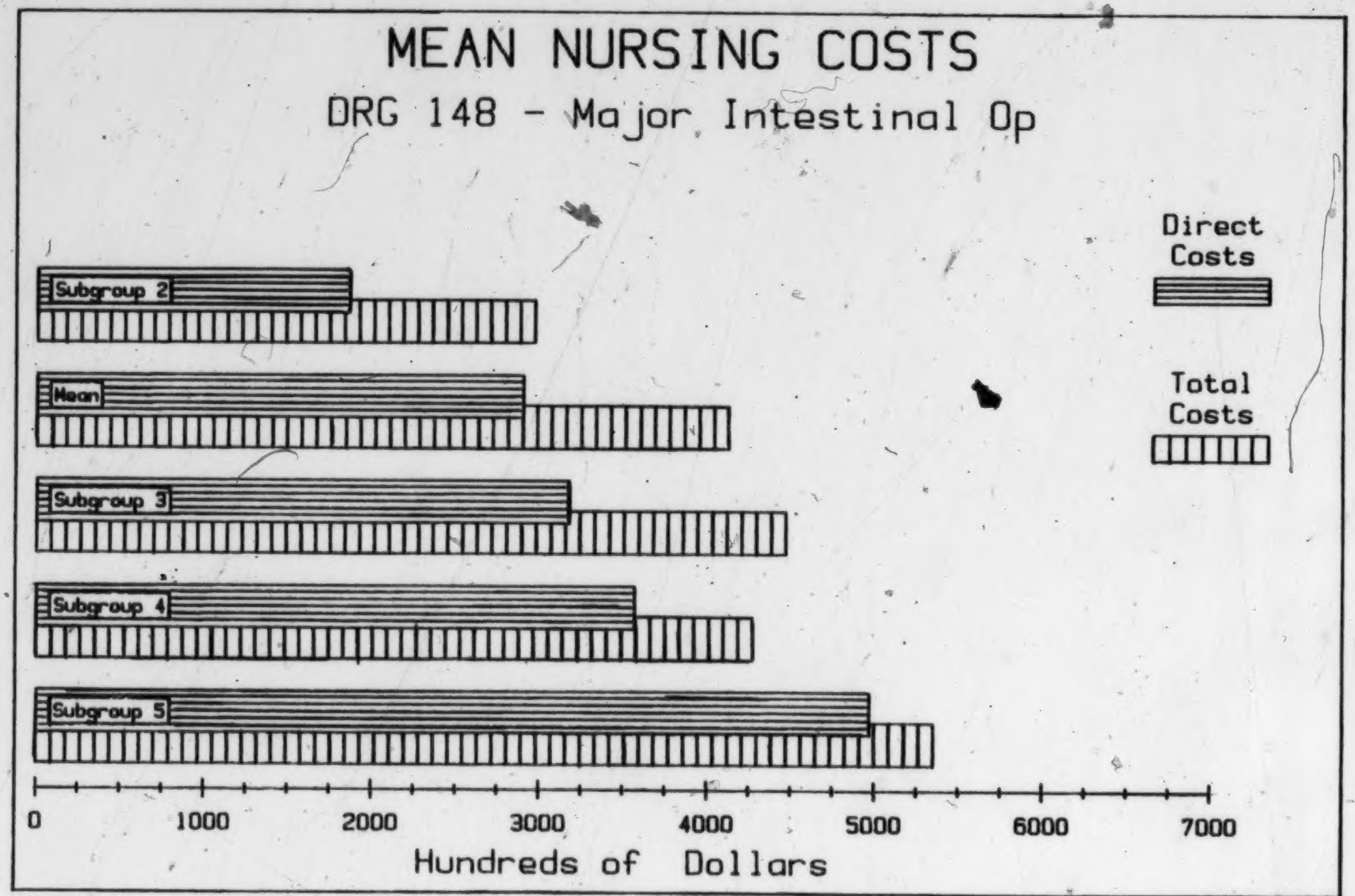

MEAN NURSING COSTS
DRG 148 - Major Intestinal Op
Direct Costs ▤
Total Costs ▥
Subgroup 2
Mean
Subgroup 3
Subgroup 4
Subgroup 5
0
1000
2000
3000
4000
5000
6000
7000
Hundreds of Dollars

Figure 7

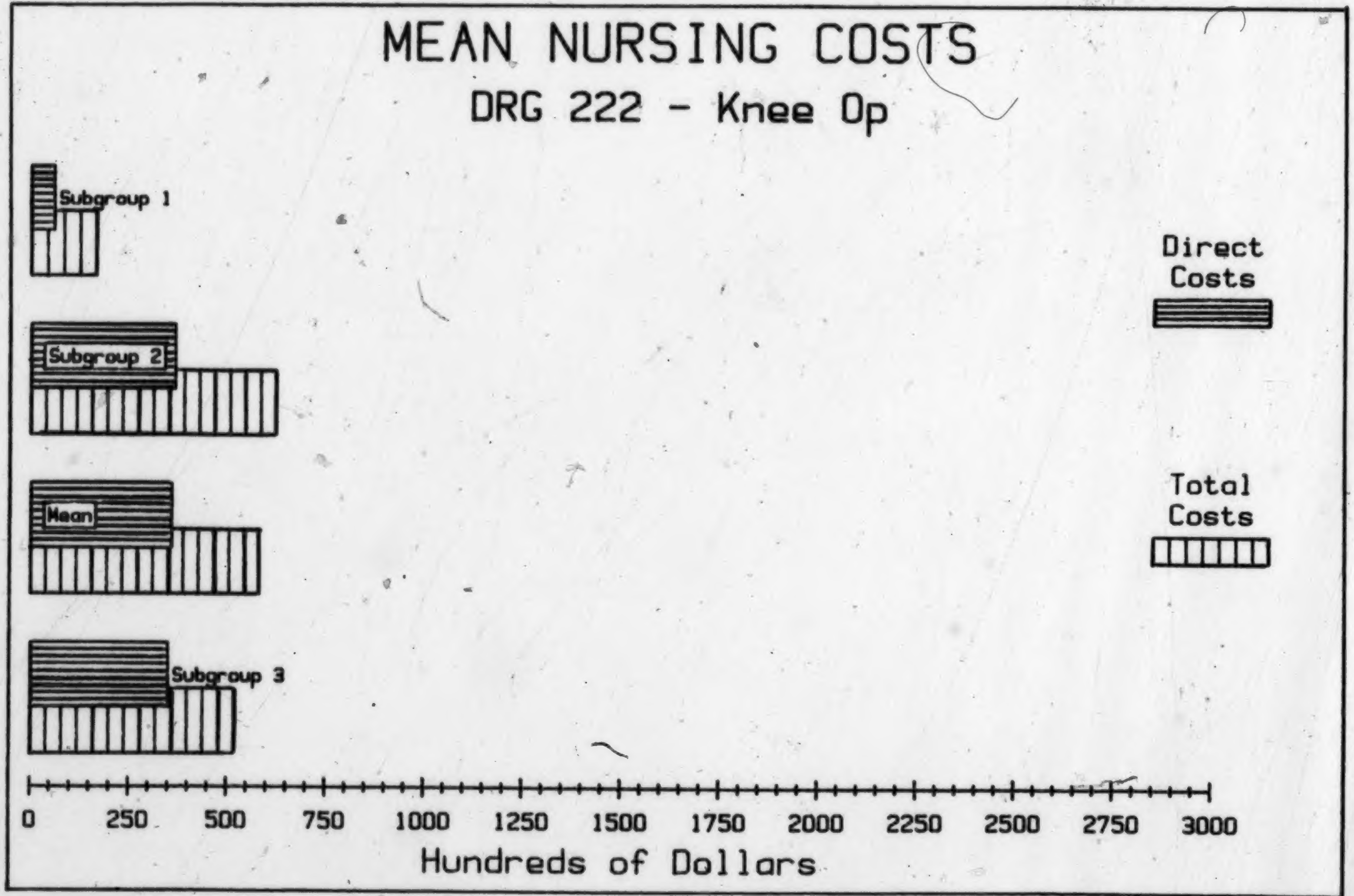

MEAN NURSING COSTS
DRG 222 - Knee Op
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Direct Costs ▤
Total Costs ▥
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
Hundreds of Dollars

Figure 8

In DRG #105 inconsistencies in the expected ordering of costs occur in complexity subgroups 1 and 4, which are each comprised of only one case. The individual in subgroup 1 had a 29 day stay in hospital, which compares with a mean stay for that DRG of 13.3 days. The respective average stays for subgroups 2 and 3 are 13 and 13.3 days. The individual in subgroup 4 died on the sixth day after admission. The daily classification data for the patients in the aberrant subgroups are given for illustrative purposes.

Patient #1 (age = 12 years) - 11112111111111433222111211111
#2 (age = 58 years) - 344444

This is probably one of many examples in this data set of a lack of relationship between stay specific consumption of nursing resources and severity or criticalness of illness. Patients who die in hospital are among the most severely ill, but they frequently experience below average lengths of stay. Although they require intensive nursing care for much of their stay, the shorter duration of hospitalization makes them less costly overall than long stay patients. Of the nine deaths which occurred in DRG #105, five (56%) were among patients in complexity subgroup 2, and three (33%) in subgroup 3. Of the 38 deaths in the total sample of 1,403 patients, twelve (32%) were among patients classified in complexity subgroups 4 and 5, while eighteen (47%) were in subgroup 3, and eight (21%) in subgroup 2. This is an indication that while the nursing complexity index developed in this research may well be suitable for case based analysis of nursing costs, it is not necessarily an appropriate measure of illness severity.

The failure of mean costs to conform to expectations among subgroups 2 and 3 in DRG #222 also requires some explanation. The two subgroups have sample sizes of 137 and 81 respectively, such that statistical stability is not a problem. There were no deaths recorded among patients in that diagnostic category, but the length of stay in subgroup 2 is higher on average (4.8 days) than in subgroup 3 (3.1 days). Only 16 (7.3%) of the 219 patients in the diagnostic group remained in hospital more than eight days, and 176 (80.1%) were discharged between the second and fifth days. The difference in mean direct costs between the two subgroups is a mere $16.80, but as can be seen in Table 15 (Appendix D, p. 210) there is a more substantial difference ($35.94) in the mean direct per diem cost across the groups. In fact, when length of stay is controlled for, all mean nursing costs (total and direct) behave exactly as anticipated and show a logical increase at each succeedingly more complex level (Tables 13 & 15, Appendix D, p. 208-210). This implies that the complexity index (i.e. the median classification score) is effective in discriminating among groups of patients with stay specific differential resource consumption patterns.

The expected increase in length of stay at higher levels of complexity does not materialize in several DRGs, even when level 4 is excluded to account for death-related atypical stays (Table 16, Appendix D, p. 211). These include DRGs #088 (COPD), #105 (Cardiac Op), #107 (Coronary Bypass), #162 (Hernia Op), #222 (Knee Op), #355 (Hysterectomy) and #430 (Psychoses). In some diagnostic categories more than in others, variation in length of stay in hospital appears to be a function of factors other than a need for nursing care. What those factors may be can only be discerned through utilization review.

4.1.6 Assessing the Impact of Increases in Subgroup Sample Size

While the mean direct costs of nursing increase with advancing levels of complexity for most DRGs, in some the incremental costs from one level to another are not marked (Appendix D, p. 209). In others, a fairly small increase in the proportion of patients in one severity level would have a significant impact on the nursing budget, because of a substantial gap in costs among the levels. This is true of DRGs #001 (Craniotomy), #088 (COPD), #209 (Joint Op), #335 (Male Pelvic Op) and #458 (Burns), depicted in Figures 4 (p. 120) and 9 through 12 on the following pages.

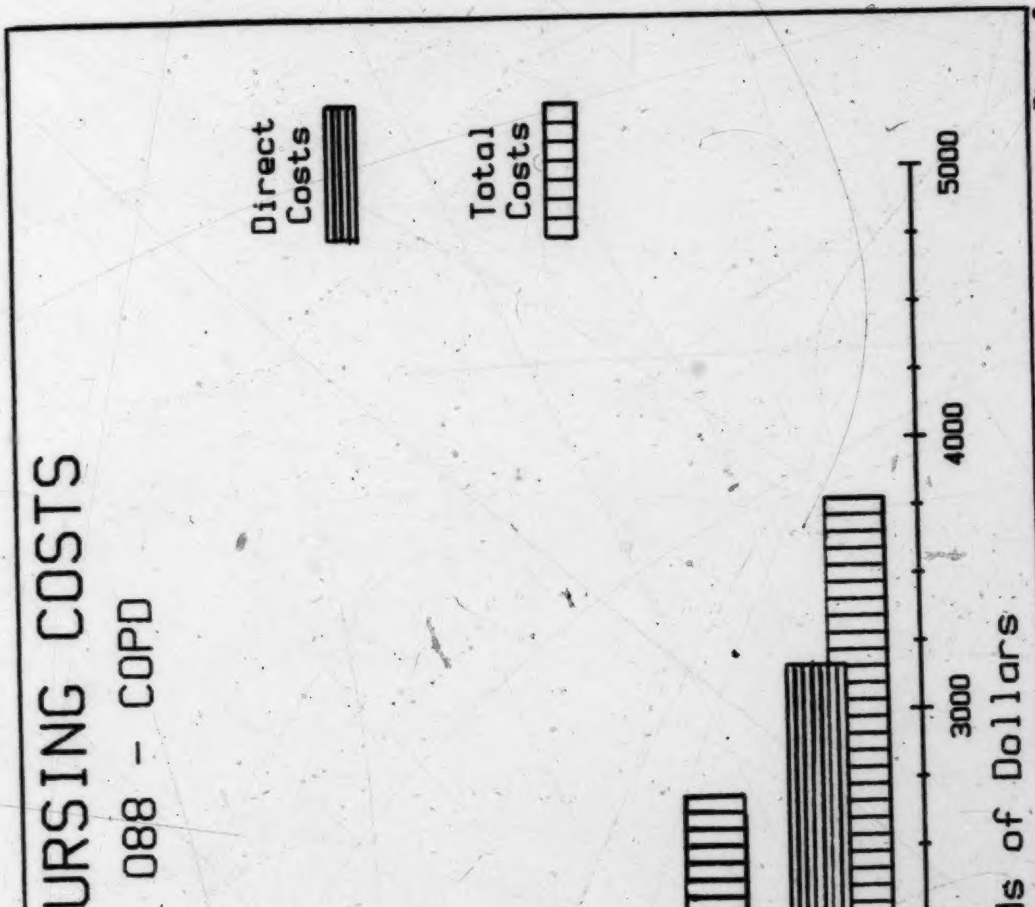

MEAN NURSING COSTS
DRG 088 - COPD
Direct Costs
Total Costs
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Subgroup 4
0
1000
2000
3000
4000
5000
Hundreds of Dollars

Figure 9

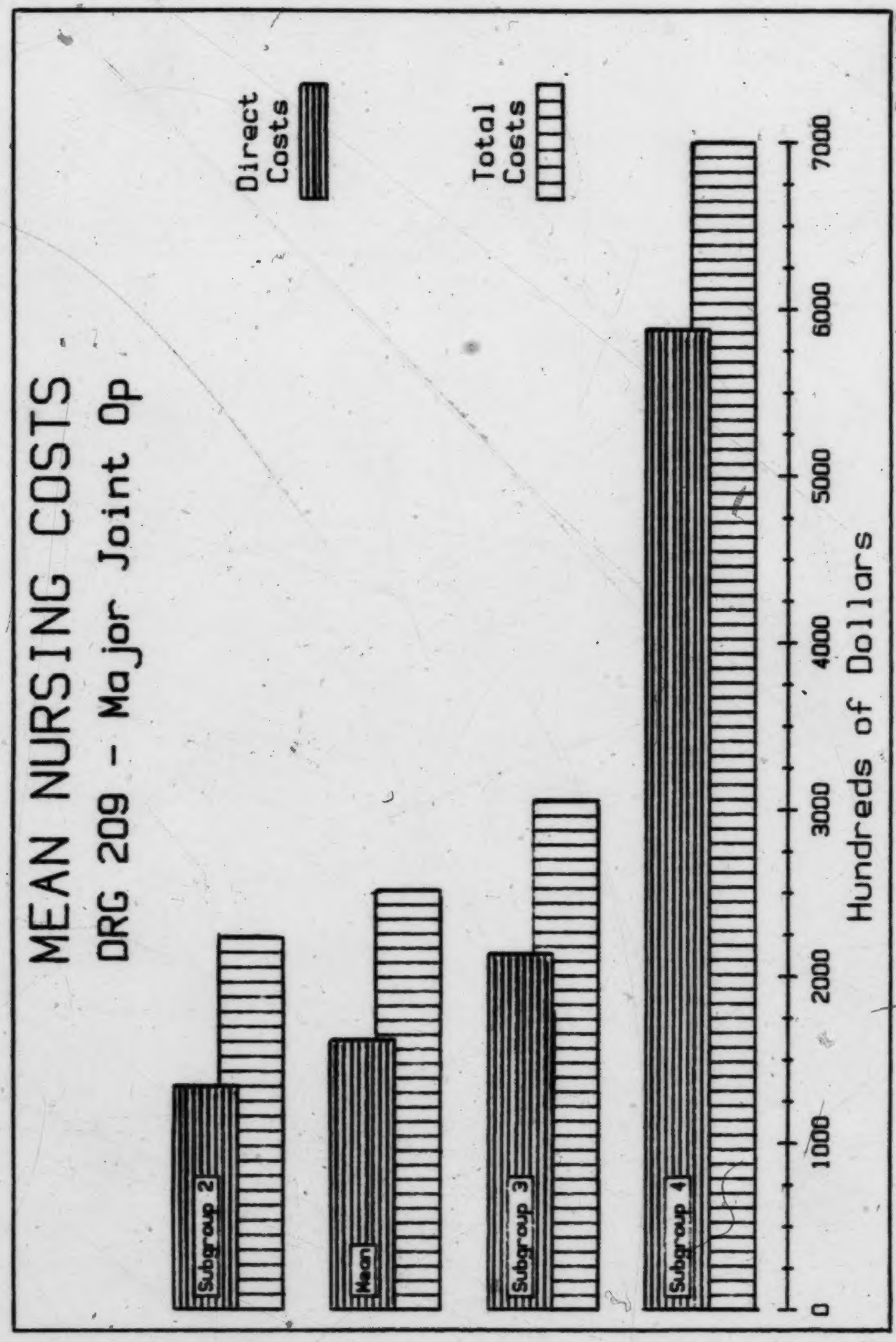

MEAN NURSING COSTS
DRG 209 - Major Joint Op
Direct Costs
Total Costs
Subgroup 2
Mean
Subgroup 3
Subgroup 4
0
1000
2000
3000
4000
5000
6000
7000
Hundreds of Dollars

Figure 10

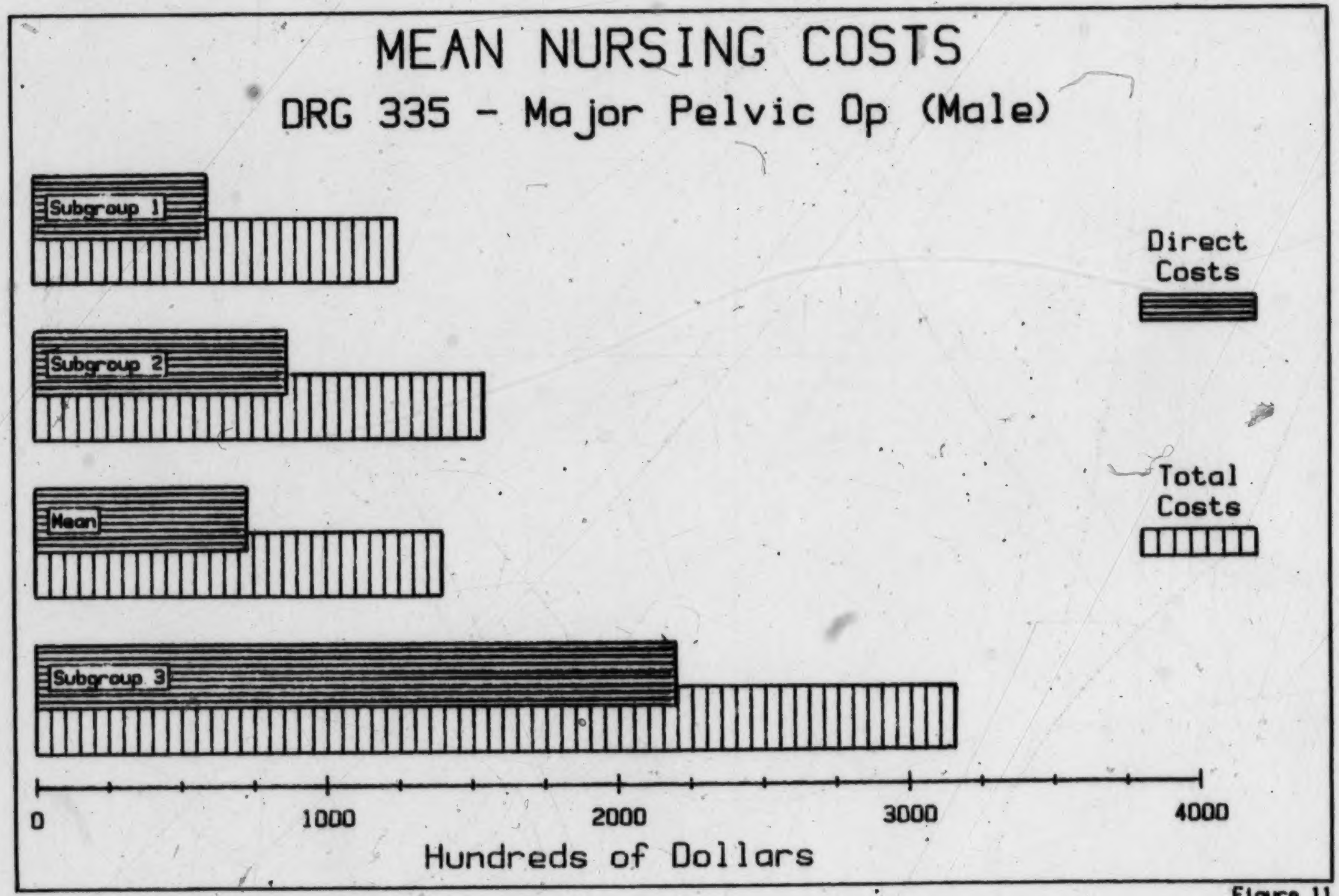

MEAN NURSING COSTS
DRG 335 - Major Pelvic Op (Male)
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Direct Costs
Total Costs
0
1000
2000
3000
4000
Hundreds of Dollars

Figure 11

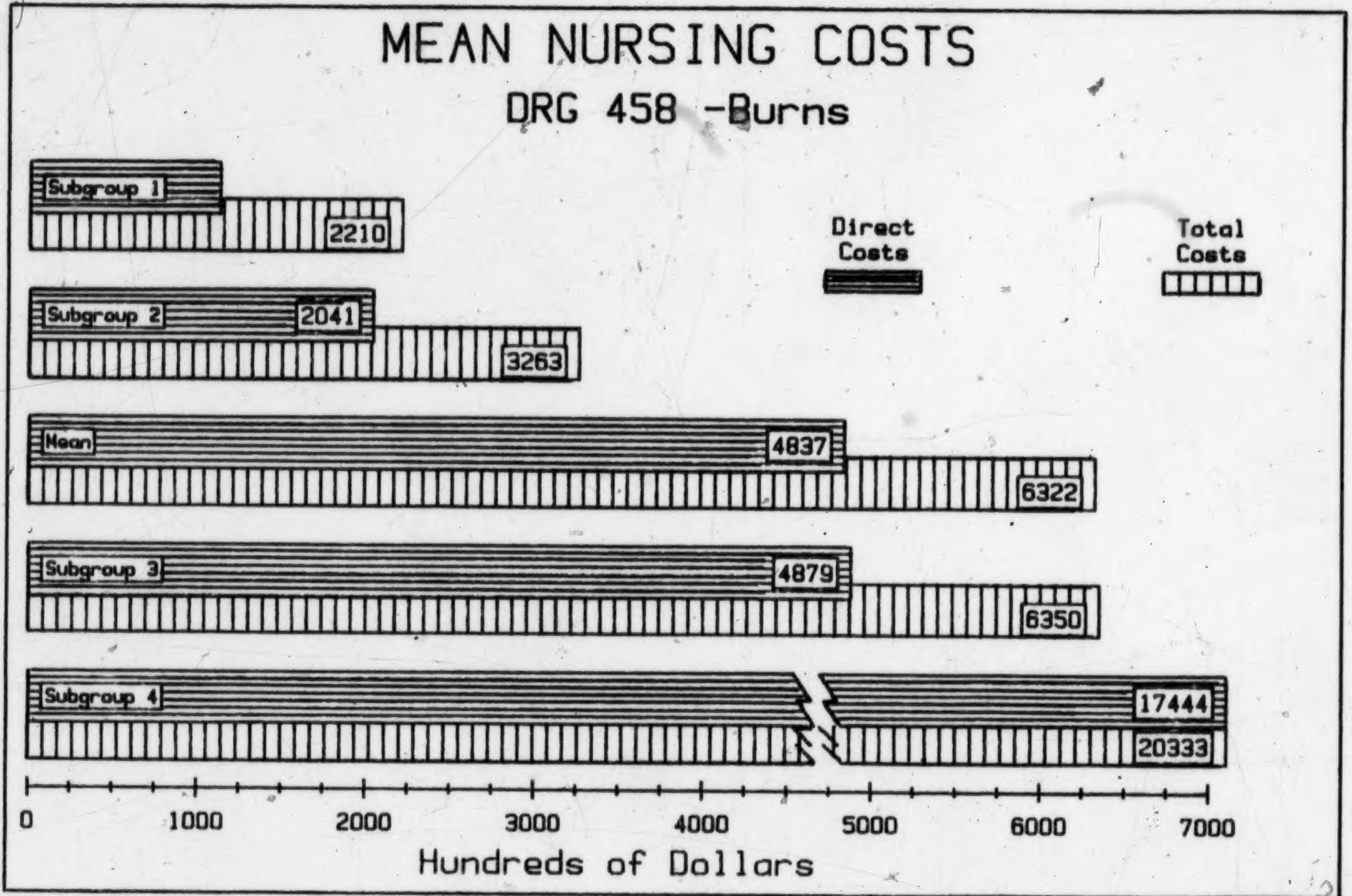

MEAN NURSING COSTS
DRG 458 -Burns
Direct Costs
Total Costs
Subgroup 1
2210
Subgroup 2
2041
3263
Mean
4837
6322
Subgroup 3
4879
6350
Subgroup 4
17444
20333
0
1000
2000
3000
4000
5000
6000
7000
Hundreds of Dollars

Figure 12

For example, there is a mean cost difference of about $3,700.00 between levels 2 and 3 in DRG #001. An increase of only three patients in complexity level 3 would add approximately $15,765 to the nursing department's cost. In DRGs #088 and #335, an increase of five patients in level 3 would increase the direct costs of nursing care by $9,630 and $10,995 respectively. The most dramatic effect would occur with a proportional increase at the most complex level in DRG #458 (Burns). An increase of only two patients would add about $35,000.00 to direct nursing costs, if the two patients classified at that level in this study accurately reflect typical level 4 cases in that diagnostic category.

The overall effect of increasing the sample size from 1,402 (excludes the level 5 patient in DRG #148) to 1,566 patients (an approximate 10 percent increase in most diagnostic category subgroups) was assessed. The results are presented in Appendix E (pp. 217-220). The addition of 164 patients increased the nursing department's costs by $308,575. This is a dramatic increase when one considers that this sample represents only nine percent of all discharges from one institution over a six month period.

4.1.7 Mean Hours of Direct Nursing Care per Day of Stay

Hospital funding in Alberta is based on global budgeting, and no specific formula is used in establishing funding levels for nursing departments. There is nonetheless a "rule of thumb" that the more intensive patients require about 4.5 hours, while the average patient requires about 3.5 hours of direct care per day. These hours were the standard used in this study to transform the classification system coefficients to a measure of resource consumption. Since many of the diagnoses included in this research are of above average nursing complexity (see Section 4.1.2) the mean hours of care per day of stay for the sample of patients in these DRGs is expected to be at least 4.5 hours or greater for much of the course in hospital. This is particularly true for DRGs #001 (Craniotomy), #105 (Cardiac Op), #107 (Coronary Bypass), #148 (Intestinal Op), #209 (Major Joint Op), #430 (Psychoses) and #458 (Burns), all of which have a costliness weight greater than 1.0.

The average hours of care per day of stay for all patients in each DRG were calculated by multiplying the number of patients in each of the classification levels (1 through 5) by the appropriate number of hours of care required, and summing over all. That number was then divided by the number of patients in each DRG still in hospital on a given day. For example, if there were 23 patients in level 2 (23 x 3.5 hours) and 32 in level 3 (32 x 8.75 hours) the average hours of care for those patients was 6.6 (285.5 ÷ 55). Hours of care were calculated only for the first 25 days of stay. The number of patients still in hospital at that time were as follows:

DRG #			Sample Size -
001	- 20	(22.5%)	89
088	- 13	(12.3%)	106
105	- 7	(11.1%)	63
107	- 2	(1.6%)	128
122	- 2	(2.4%)	85
148	- 21	(30.9%)	68
209	- 20	(14.6%)	137
335	- 6	(5.2%)	115
430	- 53	(40.8%)	130
458	- 16	(50.0%)	32

All patients had been discharged from DRGS #162, #355, and #222 by the 9th, 15th and 17th days respectively.

Figures 13 through 15 (on the following pages) demonstrate that the average level of nursing resource consumption far exceeded the 4.5 hour accepted standard of complexity for the majority of DRGs.

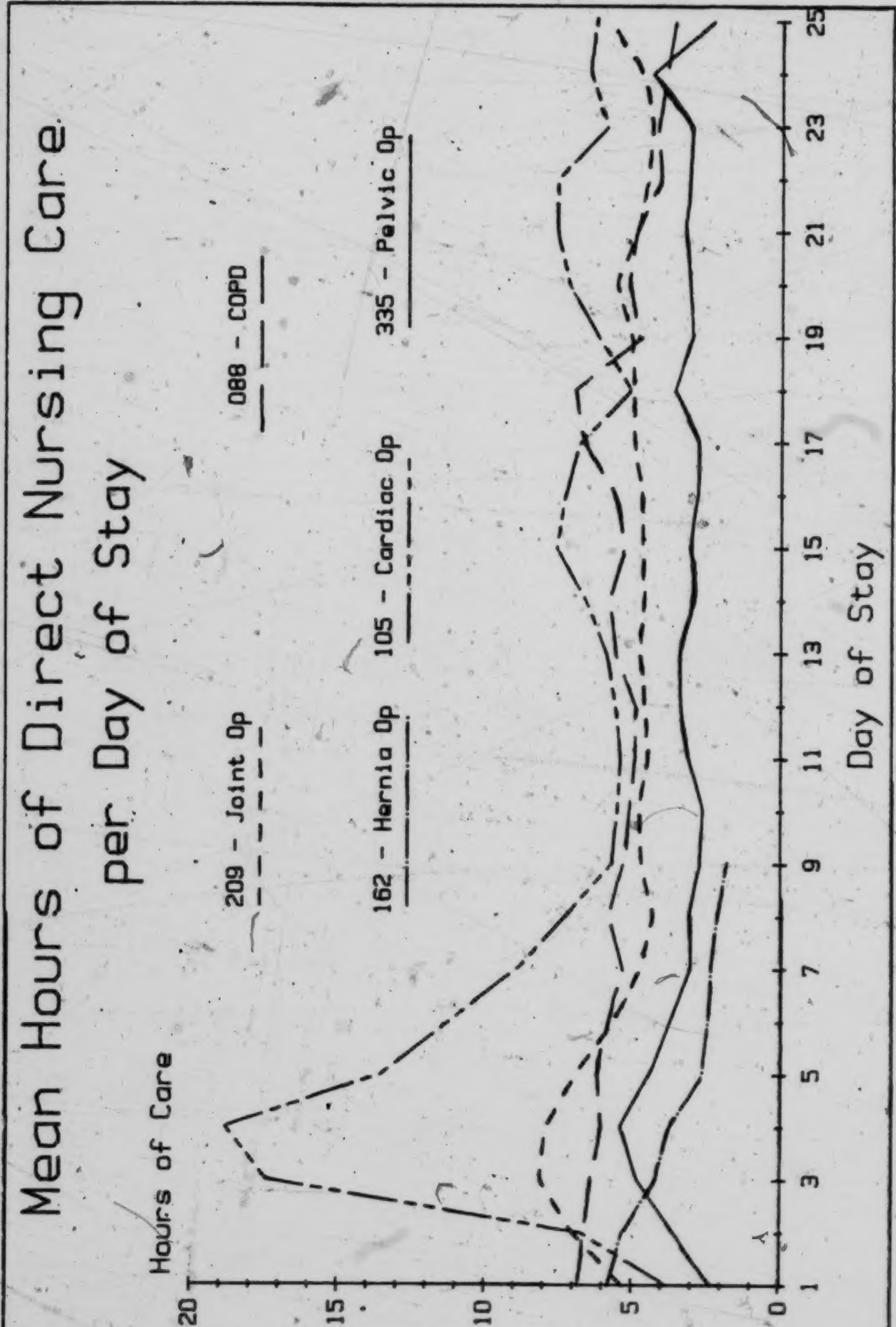

Mean Hours of Direct Nursing Care
per Day of Stay
209 - Joint Op
088 - COPD
162 - Hernia Op
105 - Cardiac Op
335 - Pelvic Op
Hours of Care
20
15
10
5
0
1
3
5
7
9
11
13
15
17
19
21
23
25
Day of Stay

Figure 13

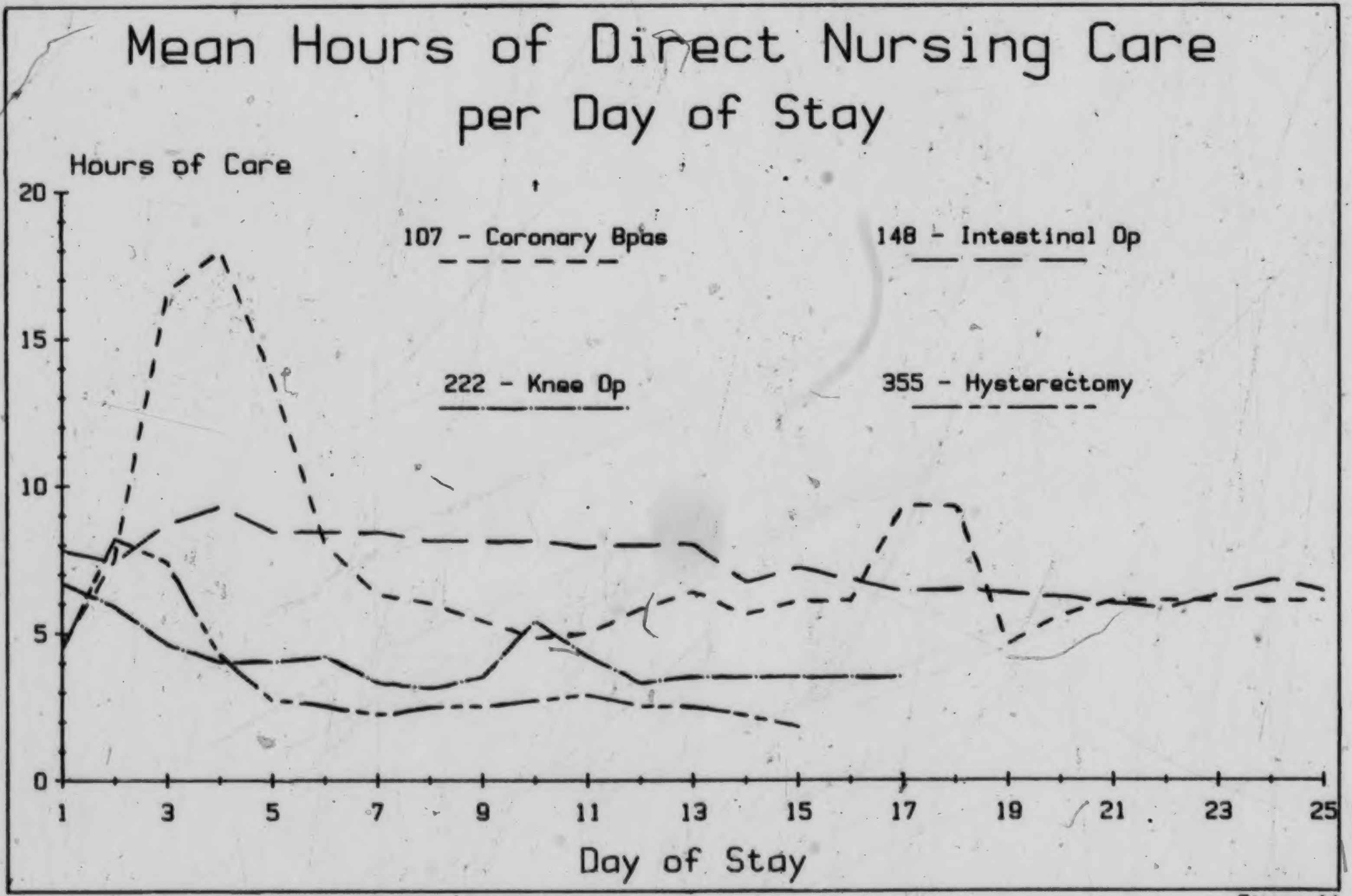

Mean Hours of Direct Nursing Care
per Day of Stay
Hours of Care
107 - Coronary Bpas
148 - Intestinal Op
222 - Knee Op
355 - Hysterectomy
20
15
10
5
0
1
3
5
7
9
11
13
15
17
19
21
23
25
Day of Stay

Figure 14

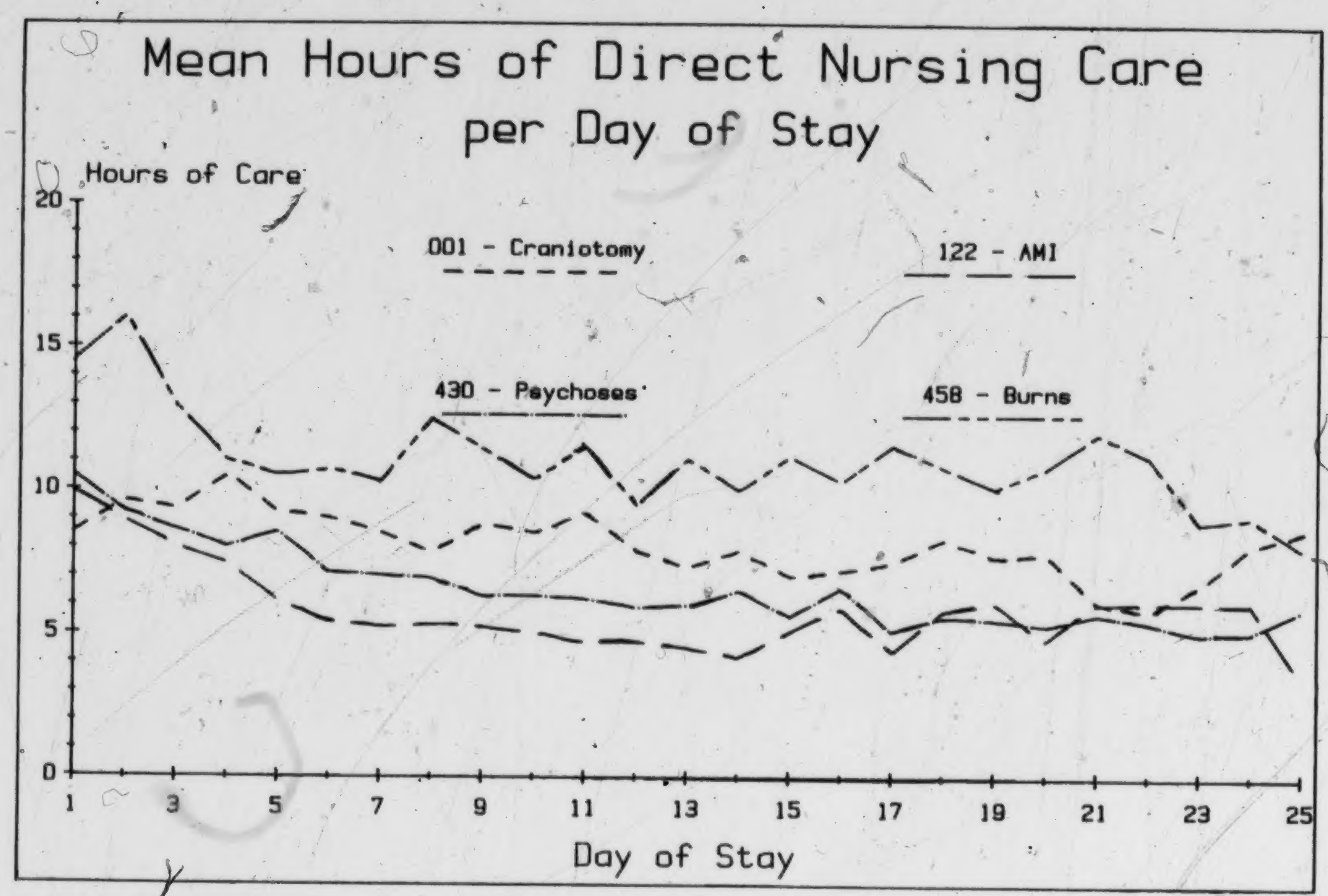

Mean Hours of Direct Nursing Care
per Day of Stay
Hours of Care
20
15
10
5
0
001 - Craniotomy
122 - AMI
430 - Psychoses
458 - Burns
1
3
5
7
9
11
13
15
17
19
21
23
25
Day of Stay

Figure 15

DRGS #001 (Craniotomy), #148 (Intestinal Op) and #458 (Burns) reflect nursing resource consumption in excess of 6 hours per day throughout the first 25 days of stay. Burn cases in particular are associated with consistently high resource use. Since 22 to 50 percent of admissions with these diagnoses are hospitalized beyond 25 days, funding levels based on 4.5 hours of nursing care per day would have serious implications for the nursing budget in this hospital.

DRGs #105 (Cardiac Valve Op) and #107 (Coronary Bypass) are characterized by very high demand for nursing resources (13 to 19 hours) from the third to fifth days of stay, presumably the immediate post-operative period. It is interesting that in both DRGs, average need for direct nursing care drops off somewhat between the ninth and twelfth days and then increases slightly, but fluctuates considerably, to day 25. This may coincide with a period when complications arise or when those remaining in hospital are at the more severe end of the illness spectrum. The peak seen in the line chart between days 16 and 19 in DRG #107 is due in part to a patient who was classified at levels 4 or 5 during the last five days preceding death.

Patients in DRG #122 (AMI) demand fairly high levels of direct care from the first day, which reflects the emergent nature of the admission, but nursing resource use drops off significantly after the fifth day.

When the mean of the daily average hours of care is computed to represent each DRG in terms of a single scalar value, the only "average" DRGs in this study are #162 (Hernia Op), #222 (Knee Op), #335 (Male Pelvic Op) and #355 (Hysterectomy). This is depicted in Figure 16 (p. 140) which illustrates just how complex this sample of DRGs really is.

4.1.8 Summary

The results discussed in the preceding section indicate that valuable information can be gained from analyzing nursing costs on the basis of case mix and level of complexity. The costliest diagnoses can easily be identified and an assessment made of the potential impact on the nursing budget of volume increases in those diagnoses. The complexity index provides very useful additional knowledge. It can help explain cost differences related to changes in the proportion of more complex cases in the absence of any change in case mix and can be used to predict the potential impact on costs of policy decisions which might affect the complexity mix (e.g. provision of pre-admission services or expansion of cardiac care facilities). In this study the complexity index has also highlighted unexpected similarities in lengths of stay among patients in the diagnostic subgroups.

Another objective of this research was to determine whether patient attributes other than medical condition might be useful in explaining variances in the nursing budget. Three patient related variables were selected for study - age, type of admission and condition at discharge. The following section describes the results of this assessment.

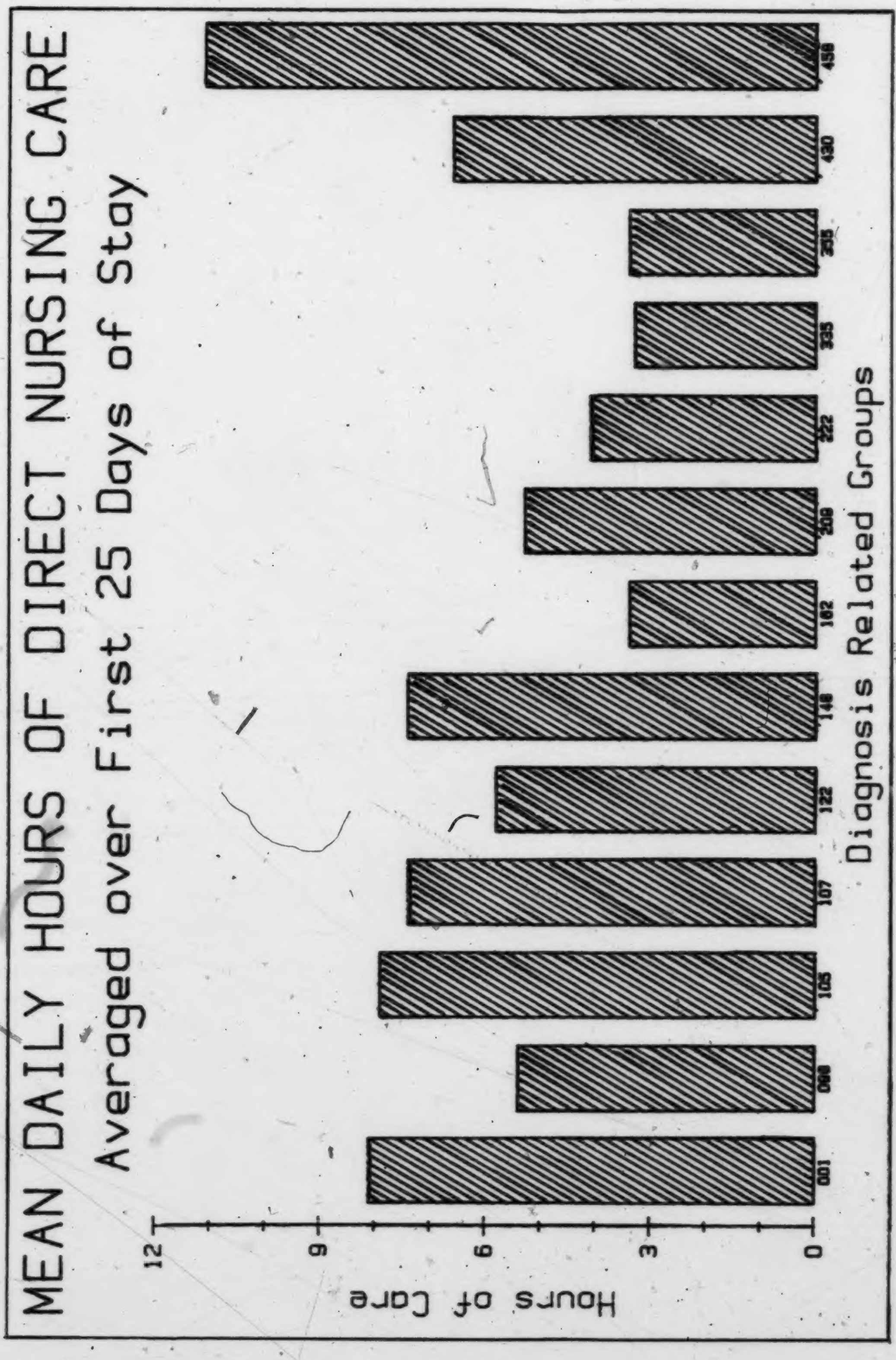

MEAN DAILY HOURS OF DIRECT NURSING CARE
Averaged over First 25 Days of Stay
Hours of Care
12
9
6
3
0
001
088
105
107
122
148
182
209
222
335
355
430
456
Diagnosis Related Groups

Figure 16

4.1.9 The Influence of Age on Nursing Costs

There is considerable evidence that age greater than 65 years is associated with increased consumption of hospital resources (Duckett & Kristofferson, 1978; Goldfarb et al, 1983). Whether that is in fact the point at which advancing age begins to influence costs is not clear. Luke (1979) noted in his study that age greater than 50 years was a valid measure of case intricacy. Some effect on nursing costs could be expected to become evident at this age. Four age distributions were selected for study in this research. Data were successively subdivided into age groups over and under ages 50, 60, 65 and 70 and analyzed by diagnostic category. As depicted in Figures 17 and 18 (pp. 142-143) the higher age category is associated with larger mean direct costs in most cases. The exceptions are DRG #222 (Knee Op), #335 (Pelvic Op), and #458 (Burns), all of which have very small sample sizes in one or the other age category (Table 17, Appendix F, p. 222). The mean age in two of these diagnostic categories (#222 and #458) is 29 and 37 years respectively, while that in DRG #335 is 70 years. The mean age and variability (measured by the C.V.) for each DRG is given in Table 10. It is interesting to note that in this sample the mean age for DRG #148 is 56 years. That DRG is the only diagnostic category included in this study in which age greater than 70 is one of the major partitioning variables (in addition to complications and/or comorbidity). In this particular group of patients, only 20 individuals (29%) were classified into DRG #148 on the basis of age.

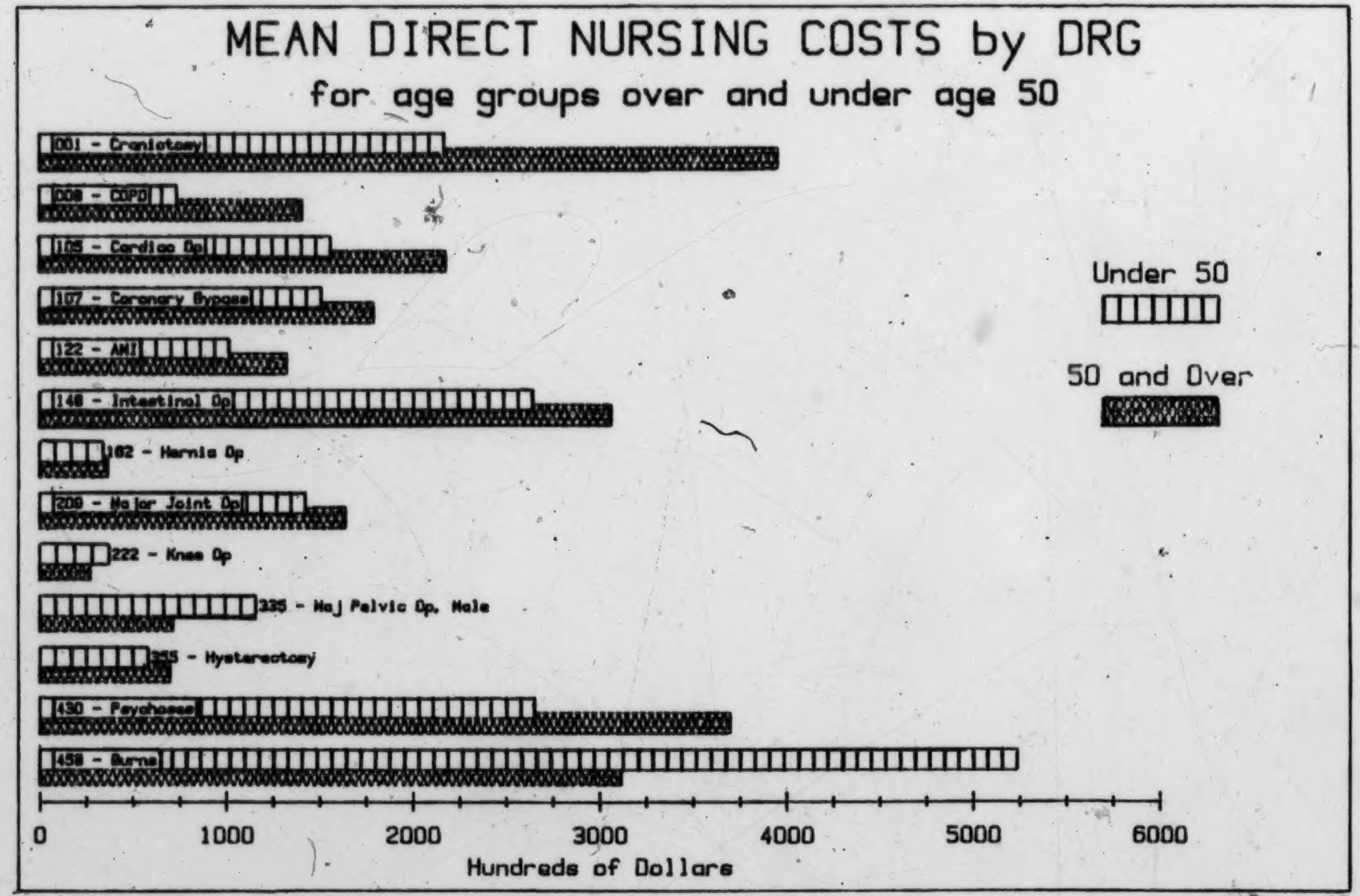

MEAN DIRECT NURSING COSTS by DRG
for age groups over and under age 50
001 - Craniotomy
088 - COPD
105 - Cardiac Op
107 - Coronary Bypass
122 - AMI
148 - Intestinal Op
162 - Hernia Op
209 - Major Joint Op
222 - Knee Op
335 - Maj Pelvic Op. Male
355 - Hysterectomy
430 - Psychoses
458 - Burns
Under 50
50 and Over
0
1000
2000
3000
4000
5000
6000
Hundreds of Dollars

Figure 17

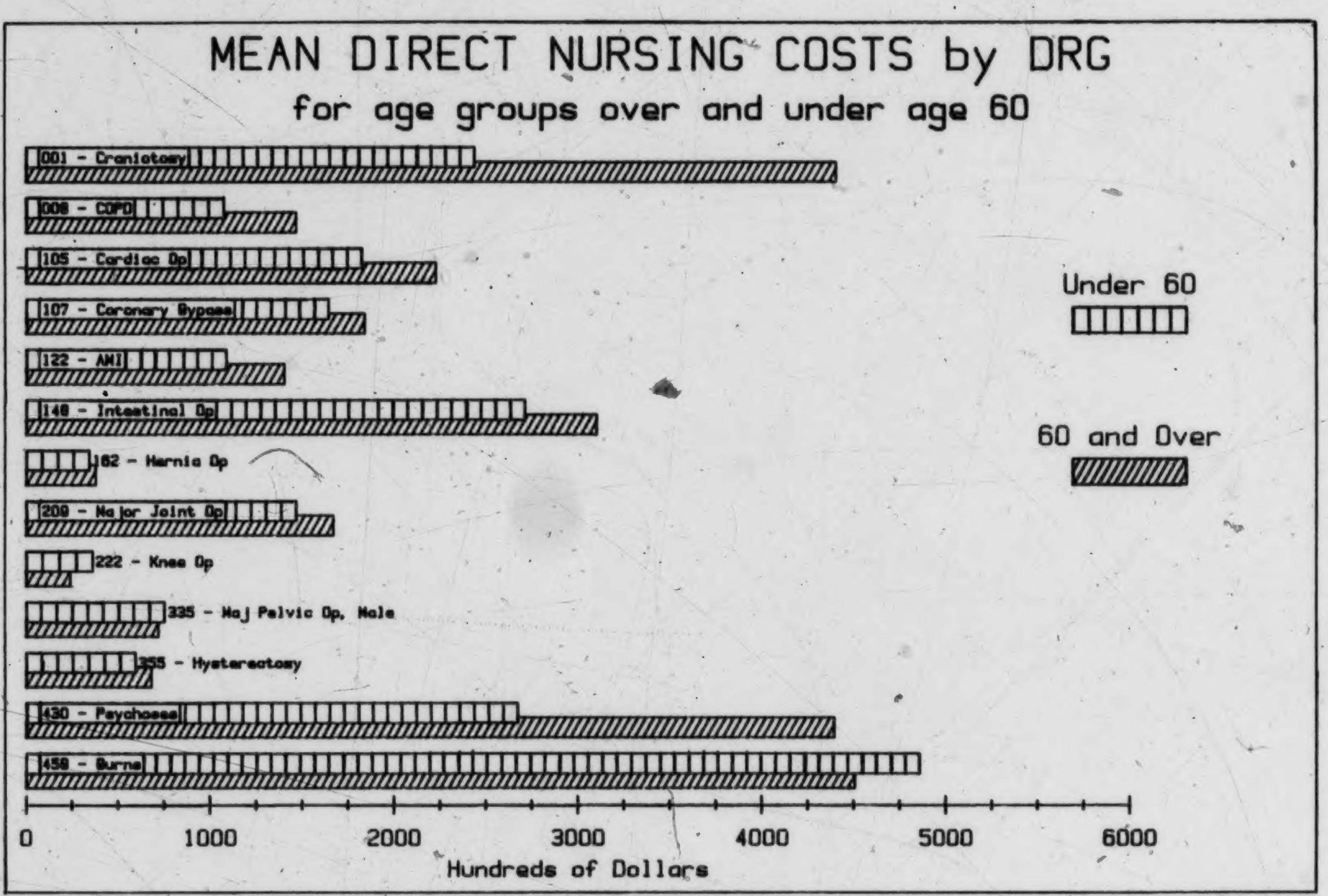
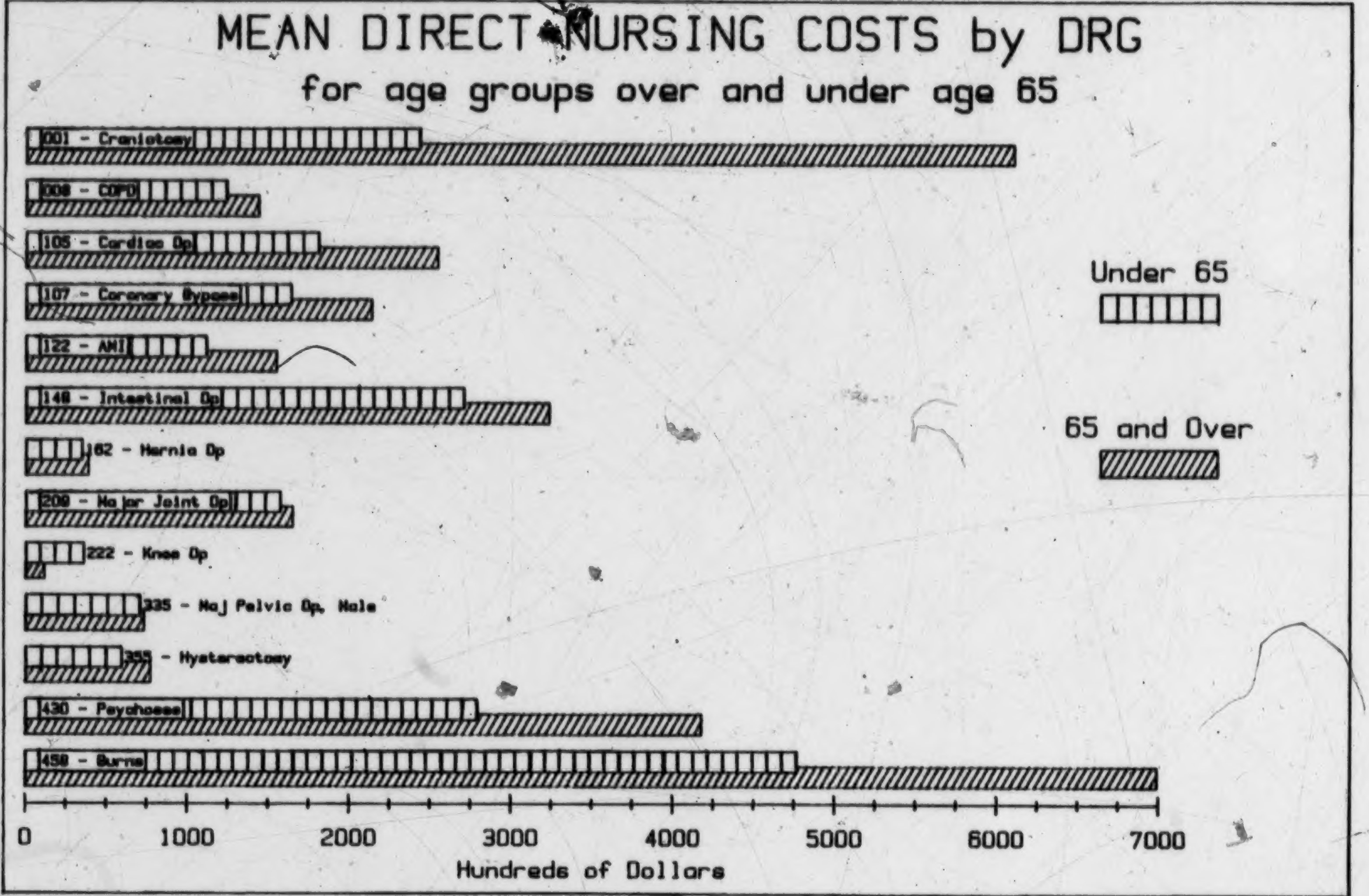

MEAN DIRECT NURSING COSTS by DRG
for age groups over and under age 60
001 - Craniotomy
008 - COPD
105 - Cardiac Op
107 - Coronary Bypass
122 - AMI
148 - Intestinal Op
162 - Hernia Op
209 - Major Joint Op
222 - Knee Op
335 - Maj Pelvic Op, Male
355 - Hysterectomy
430 - Psychoses
458 - Burns
Under 60
60 and Over
0
1000
2000
3000
4000
5000
6000
Hundreds of Dollars

Figure 18

TABLE 10 MEAN AGE AND VARIABILITY BY DRG

DRG	001	088	105	107	122	148	162	209	222	335	355	430	458
Mean Age	48	63	52	55	57	56	50	66	29	70	42	37	32
C.V.	.33	.26	.30	.19	.22	.41	.26	.20	.42	.15	.25	.44	.54

The DRGs for which age appears to play a major role vis-a-vis costs are #001 (Craniotomy) and #430 (Psychoses). For DRGs #430 and #088 (COPD) subdividing the age groups beyond age 60 diminishes the gap between the lower and higher age categories. While advancing age is consistently associated with higher mean costs in DRGs #001 (Craniotomy) and #458 (Burns) the most dramatic difference occurs beyond age 65, as depicted in Figures 19 and 20 on the next two pages. (Please note the change in dollar values along the X-axis.) Other DRGs in which subdividing the groups at age 65 appears significant include #105 (Cardiac Valve Op), #107 (Coronary Bypass), #122 (AMI), and #355 (Hysterectomy). The only DRG in which age greater than 70 continues to exert a major influence on costs is #001. These results appear consistent with the widely held view that elderly patients tend to consume proportionately more of the hospital's resources. While it has been proposed that this greater consumption of resources is related at least partly to longer lengths of stay, it is obvious from this study that advancing age is also associated with higher average consumption of direct nursing care. The impact of an aging population on the nursing department's costs was estimated for this sample of patients (Appendix F, p. 226). As can be seen, a 10 percent increase in the number of individuals aged 65 years or more would



MEAN DIRECT NURSING COSTS by DRG

for age groups over and under age 65

Figure 19

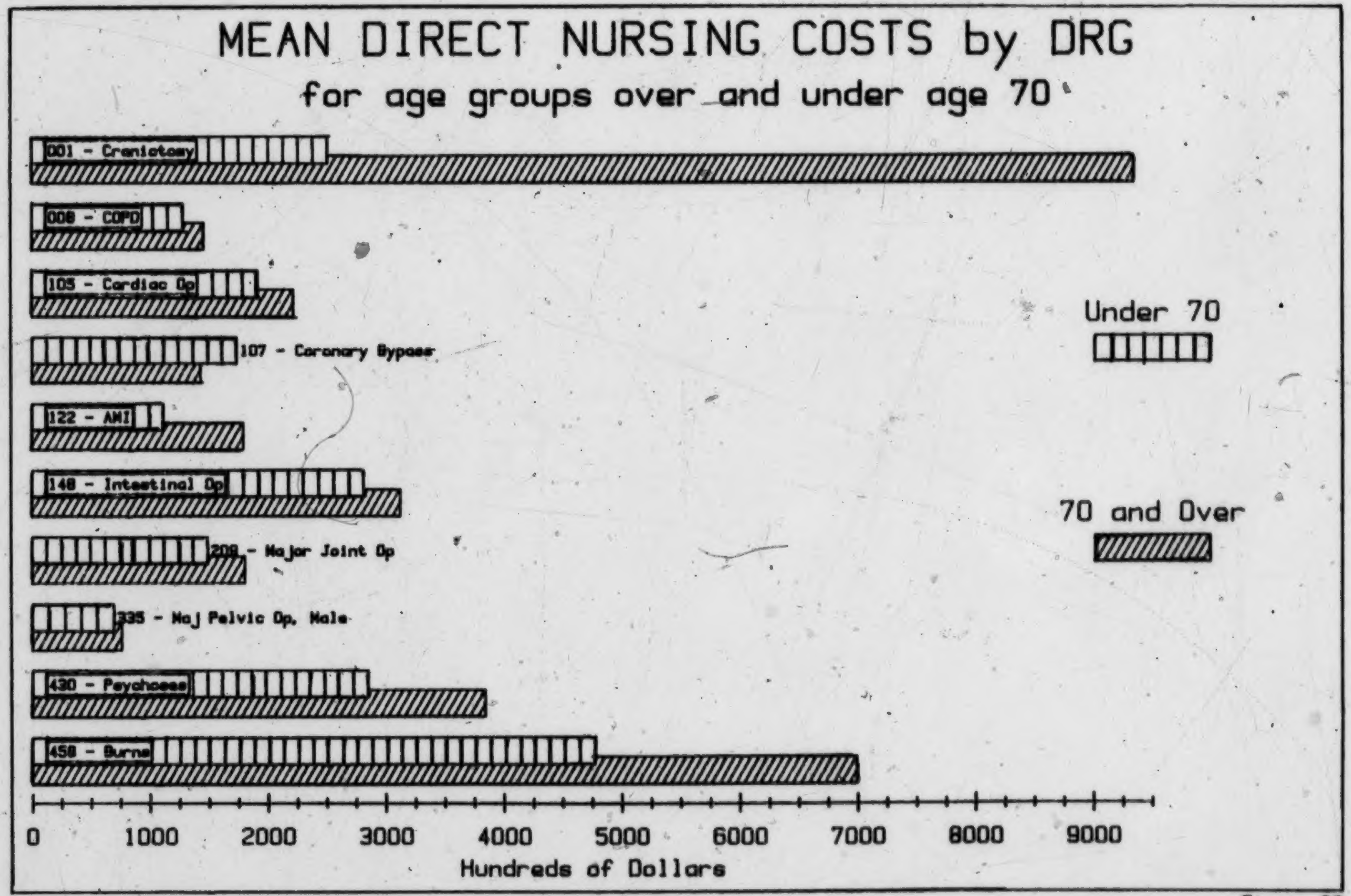

MEAN DIRECT NURSING COSTS by DRG
for age groups over and under age 70
001 - Craniotomy
008 - COPD
105 - Cardiac Op
107 - Coronary Bypass
122 - AMI
148 - Intestinal Op
209 - Major Joint Op
335 - Maj Pelvic Op, Male
430 - Psychoses
458 - Burns
Under 70
70 and Over
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Hundreds of Dollars

Figure 20

25

add $57,150.00 to the nursing department's costs, all else being equal. Although this amount may not appear significant, it must be noted that this sample included only 333 individuals aged 65 years or more. If projected to the Alberta population as a whole, it is easy to see that an aging population could increase the cost of providing hospital nursing care by a substantial amount.

4.1.10 Mean Direct Nursing Costs by Type of Admission

Emergency admission and transfer from another acute care facility are assumed to reflect in part acuity of illness. Individuals in these admission categories are likely to require considerable nursing care for at least the first few days in hospital. This should increase their overall dependence on the nursing staff, relative to elective admissions.

The mean direct costs of nursing care were computed for patients grouped into elective and emergency categories to determine whether the variable "Type of Admission" was a useful measure of complexity (i.e. nursing resource use). As illustrated in Figure 21 (p. 148) emergency admission has a variable effect on the mean direct costs of nursing care. Surgical admissions which are normally scheduled electively (i.e. #105, #107, #222, #355) are associated with the least cost differentials between the two categories of admission. On the other hand, Burns (#458) and AMI (#122) which routinely have proportionately far more urgent than elective admissions demonstrate a substantial gap in direct mean costs between elective and urgent admissions.

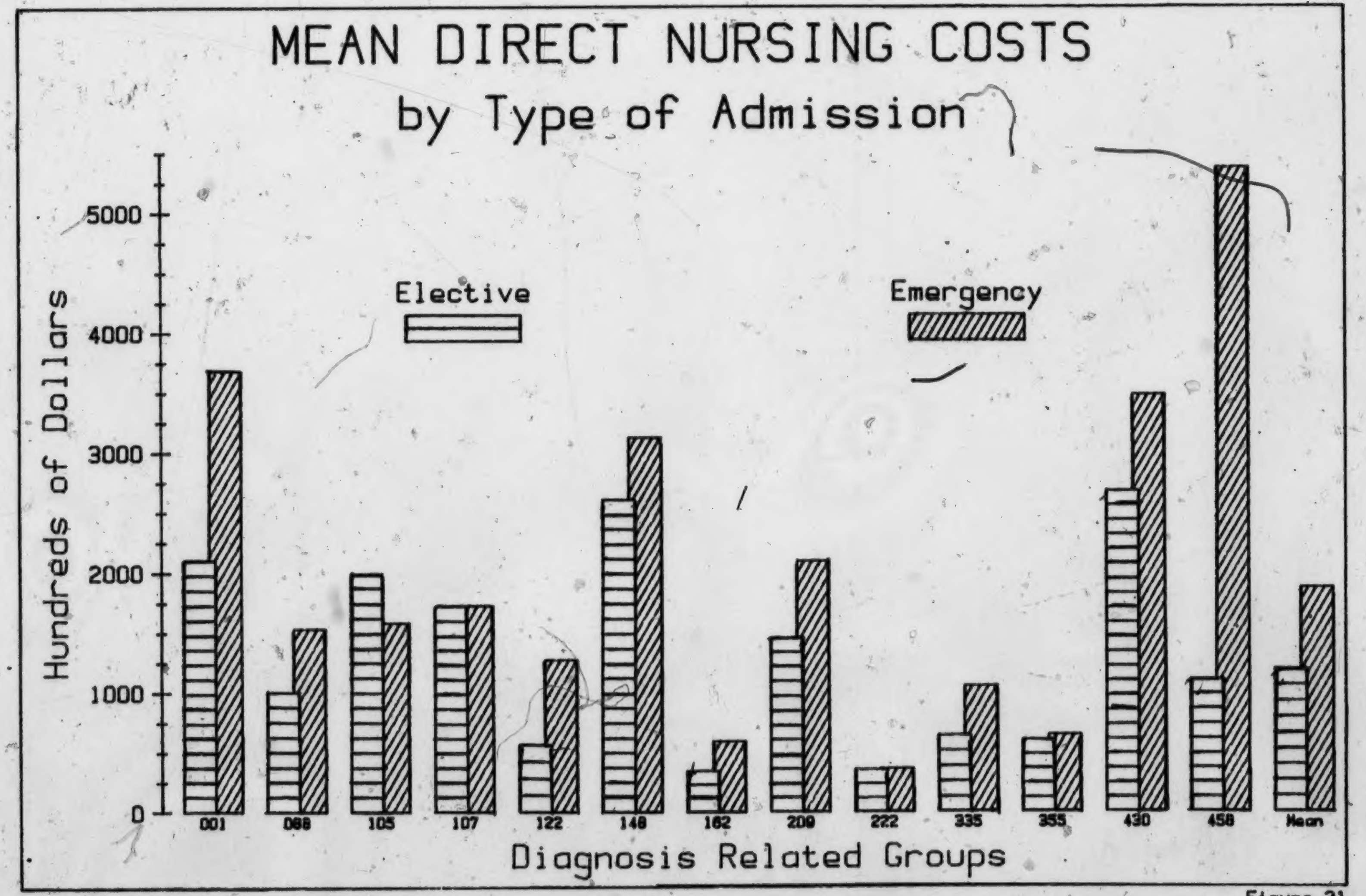

MEAN DIRECT NURSING COSTS
by Type of Admission
Hundreds of Dollars
0
1000
2000
3000
4000
5000
Elective
Emergency
001
088
105
107
122
148
162
209
222
335
355
430
458
Mean
Diagnosis Related Groups

Figure 21

Figure 21 demonstrates that for many diagnoses the type of admission can be used to explain variances in the nursing budget. Increases in the relative number of emergency admissions in DRGs #001 (Craniotomy), #088 (COPD), #148 (Intestinal Op), #209 (Joint Op), #335 (Male Pelvic Op), and #430 (Psychoses) could be expected to affect the nursing budget quite substantially since they are associated with costs per case which in some instances far exceed the group mean for the respective DRGs (Appendix F, p. 224).

4.1.11 Mean Nursing Costs by Condition at Discharge

Patients who die in hospital are presumably critically or terminally ill, while those transferred to other acute or long term care facilities must still require some nursing care at the time of discharge. In either case, patients in these two categories could be expected to consume more nursing resources during hospitalization than patients discharged to their own homes. Figures 22 and 23 (pp. 150-151) illustrate the validity of this intuitive supposition. In DRGs #001 and #088 the mean cost for the deceased group far exceeds that for patients discharged home, or (to a lesser extent in DRG #001) transferred to another facility. In these two diagnostic categories the average length of stay for the deceased group (21.5 and 22.7 days) is the same as or greater than that for all patients in the DRG (21.5 and 14.1 days respectively for DRGs #001 and #088). In all other DRGs in which deaths occurred, deceased patients experienced shorter lengths of stay than the group average.

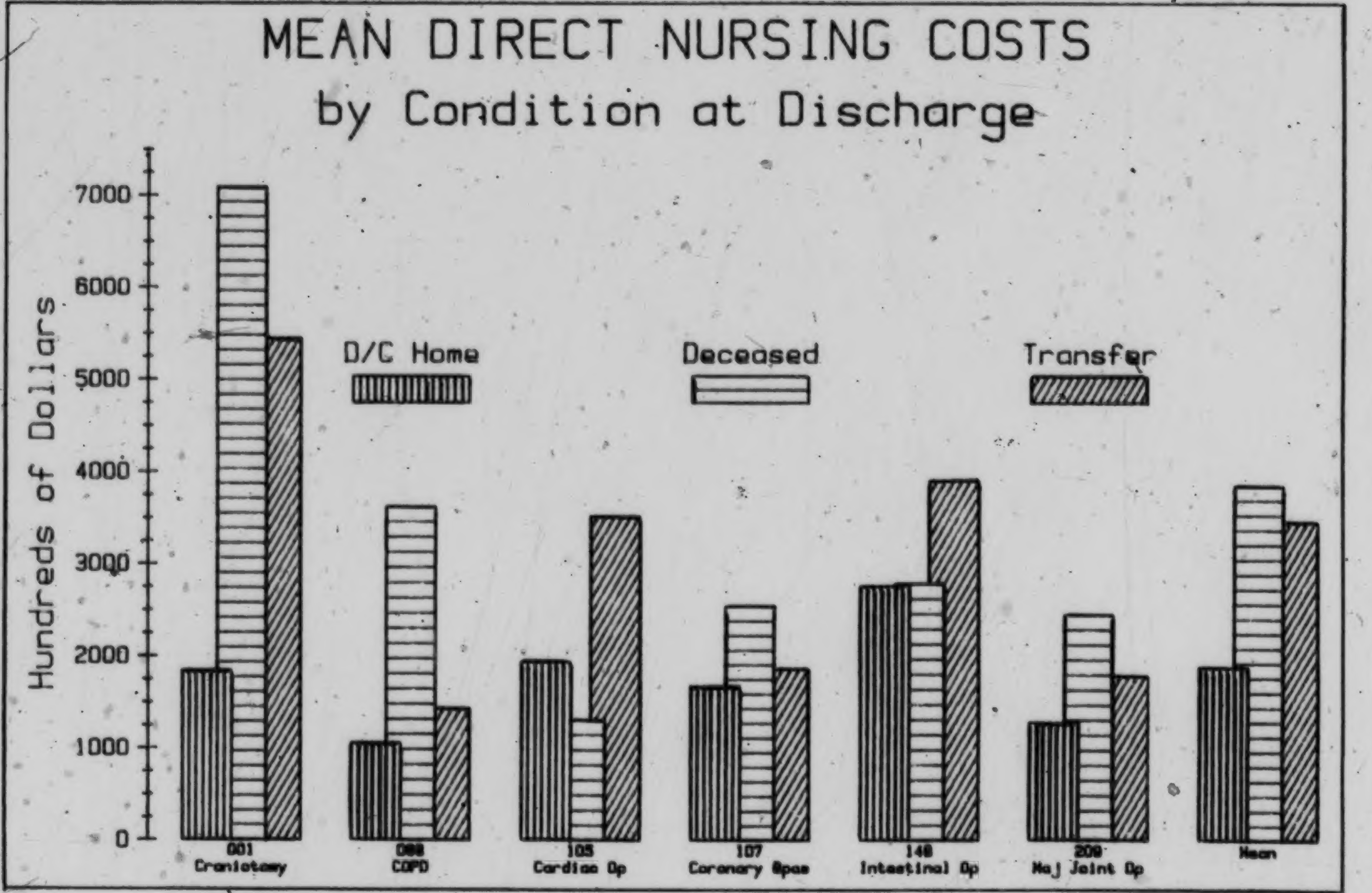

MEAN DIRECT NURSING COSTS
by Condition at Discharge
Hundreds of Dollars
0
1000
2000
3000
4000
5000
6000
7000
D/C Home
Deceased
Transfer
001 Craniotomy
088 COPD
105 Cardiac Op
107 Coronary Bypas
148 Intestinal Op
209 Maj Joint Op
Mean

Figure 22

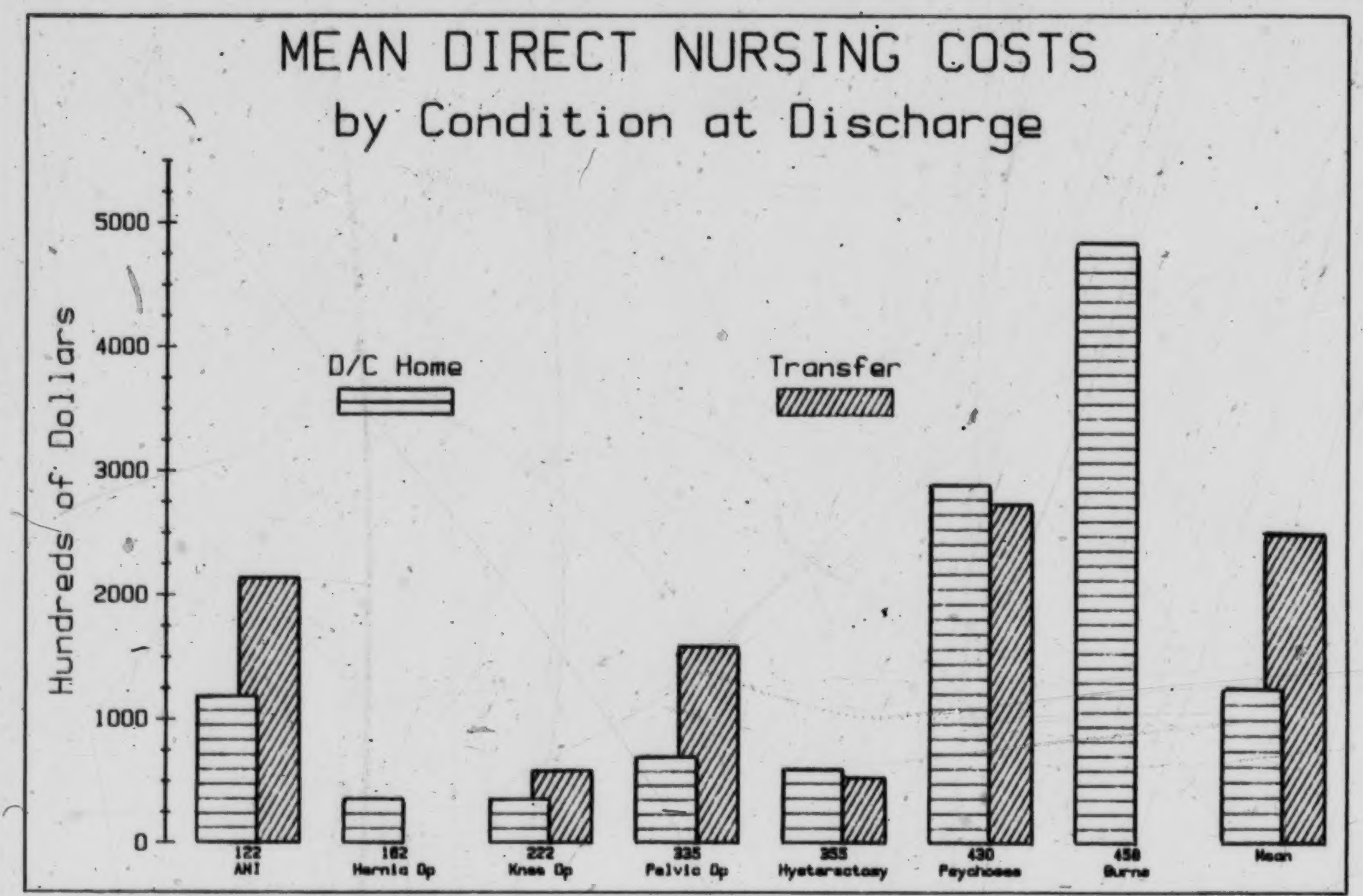

MEAN DIRECT NURSING COSTS
by Condition at Discharge
Hundreds of Dollars
5000
4000
3000
2000
1000
0
D/C Home ☰
Transfer ▨
122
AMI
162
Hernia Op
222
Knee Op
335
Pelvic Op
355
Hysterectomy
430
Psychoses
458
Burns
Mean

Figure 23

The average stay of deceased patients was 6.6 (DRG #105), 10.8 (#107), 14.3 (#148) and 11 (#209) days respectively. In both DRGs #107 and #209, despite shorter than average stays, the highest mean nursing costs are experienced by the deceased group. These patients appear to require inordinate amounts of nursing care per day of stay. In DRGs #105 and #122, proportionately few patients (6% and 3.5% respectively) contribute to substantially higher mean nursing costs for the "transfer" group. About 60 percent of patients in DRG #209 (Major Joint Op) are discharged to other care facilities (only 25% are urgent admissions or transfers from other institutions).

The patient related variables discussed above have some influence on the mean direct costs of nursing care particularly for certain diagnoses. Since there is little difference in mean lengths of stay across complexity subgroups, they appear unimportant for predicting the duration of stay, a finding consistent with previous research (McClain & Selhat, 1984). DRGs purport to cluster together patients with similar lengths of stay, which is certainly borne out in this study. It is also claimed that patients in the DRG categories have similar resource consumption patterns. If that is so, there seems not to be a necessarily strong link between need for nursing care (a primary service provided by hospitals) and consumption of total hospital resources (a measure of output). Factors other than diagnosis or those patient attributes included in this study also influence the duration and cost of hospital care.

4.2 Statistical Significance of the Findings

Previous sections in this chapter demonstrate there are unquestionable differences in mean nursing costs both across and within the diagnostic categories included in this study. Selected patient attributes are also important determinants of nursing costs. It was noted in section 4.1.5 that substantial variation in cost nonetheless exists among the complexity levels formed by use of the median classification score. It is therefore important to question whether the observed mean differences among and within the diagnostic categories truly represent differential consumption of nursing resources, or whether they are merely a function of sampling error. In other words, what is the likelihood that the means of DRGs and complexity subgroups differ simply due to sample size and to individual differences among the patients? One way analysis of variance (ANOVA) is used to address this issue. In ANOVA, the squared deviation of scores from the group mean is partitioned into between-group and within-group estimates of variance. Between-group variance is determined by the deviation of each group mean from the mean of all scores in the sample, and reflects both the variability of individual subjects and differences in the means of the various groups. Within-group variance is a reflection only of individual deviation of scores within a particular group about its mean. If groups differ substantially, the between-group variance estimate is large. Under the null hypothesis that the means of the various groups are identical, both between and within variance estimates should be about the same. If the ratio of the two variance estimates is large, the null hypothesis is rejected (McCall, 1974, pp. 236-239). This ratio is the F statistic.

4.2.1 Assessing Group Differences Across DRGs

The first hypothesis to be tested is that there are no differences in mean costs across DRGs. The ANOVA table for the first test of the hypothesis is provided for illustrative purposes. The F value and probability values for all subsequent hypothesis tests referred to in this section are provided in Appendix G (pp. 228-236).

Hypothesis #1

Ho: There are no differences in mean nursing costs across DRGs.

Dependent Variable: Direct Nursing Cost

Degrees of Freedom: Numerator = DRGs - 1 = 11

Denominator = N (1371) - #DRGs = 1,359

Source	SS	df	Mean Square (SS-df)	F
SS Between	1174118886·33215490	11	106738080·57565045	41.02
SS Within	3536417173·54320930	1,359	2602220·14241590	
SS Total cfm	4710536059·87536400	1,370		

The level of significance (i.e. the probability of falsely rejecting the null hypothesis) was set at .05. This means that the probability that the hypothesis is correctly rejected when it is is true is 95 percent (Cockerill, 1983).

Because of the very small sample size in DRG #458 (Burns), it was excluded from analysis of variance procedures. In addition, the two individuals in subgroups 4 and 5 in DRG #148 were collapsed into level 4, such that the analysis involves no more than four complexity levels. The data analysis henceforth deals only with the remaining twelve DRGs. To test the hypotheses, the Statistical Analysis Systems (SAS) computer package was used. When cell sizes are unequal, as in this case, SAS recommends the General Linear Model (GLM) for one way analysis of variance to ensure validity of the results (SAS, 1982 p. 119).

To test the first hypothesis, direct nursing costs as well as total and per diem costs were used as the dependent variable in the model. DRG, the independent variable, has twelve levels (ie. 12 DRGs) and the number of patients in the data set is 1,371 (remaining after 32 cases in DRG #458 were excluded).

The critical value of F at 11 and 1,359 degrees of freedom at the .05 level of significance is 1.79 (McCall, 1979). The observed value of F is 41.02 (Table 23, Appendix G, p. 228). The probability that these results would be observed by chance alone is .0001. The null hypothesis is therefore rejected.

The analysis of variance tests of the hypothesis that mean costs do not differ across DRGs equally resulted in rejection of the null when total and per diem costs were used as the dependent variable. This is not an unexpected finding, since the DRG system claims to differentiate diagnostic categories on the basis of their mean costs. The results strongly suggest that consumption of nursing resources also varies significantly across diagnoses.

One-way anova (PROC GLM) was also used to determine whether there were statistically significant differences in length of stay across diagnoses. The resultant F test (52.54) supported the claim that DRGs separate groups of individuals who differ with respect to duration of hospitalization (Table 30, Appendix G, p. 235).

4.2.2 Assessing Subgroup Differences Within DRGs

Hypothesis #2

Ho: There is no mean difference in costs among subgroups in each DRG.

One-way analysis of variance was used with each of the twelve DRGs sequentially to assess the degree to which the complexity index successfully discriminates among groups of individuals within DRGs who truly differ in terms of nursing resource use. Only direct and per diem nursing costs were included as dependent variables in the model.

Statistically significant differences in direct mean costs across complexity subgroups are found in all DRGs except #105 (Cardiac Valve Op), #148 (Major Intestinal Op), #162 (Hernia Op) and #222 (Knee Op). It will be recalled that these same DRGs did not demonstrate a logical ordering of mean *total* costs among the complexity levels. When length of stay is held constant, however, statistically significant differences in mean *per diem* nursing costs are found in all twelve DRGS (Table 27, Appendix G, p. 232).

Significant differences in mean length of stay are demonstrated for DRGs #162 and #222 only (Table 30, p. 235). In both of these DRGs, the mean length of stay is considerably less for individuals in complexity subgroup 3 (3.6 and 3.1 days) than for those in subgroup 2 (5.2 and 4.8 for DRGs #162 and #222 respectively).

These data suggest that while real differences in actual need for nursing resources exist across complexity subgroups (as evidenced by per diem mean costs), inconsistencies in lengths of stay tend to equalize the groups on their overall consumption of nursing care throughout the course of hospitalization. The incongruity in length of stay in DRG #148 is explained by the fact that the two individuals in subgroup 4 died after seven and thirteen days in hospital respectively, but required intense nursing care during their stay. The average length of stay for DRG #148 is 22.7 days, and for complexity subgroups 2 and 3 it is 20.5 and 23.9 days respectively. The degree of variability in mean direct costs for all individuals in DRG #148 (range $743. - $11,602.) is obviously such that it reduces the ratio of the between and within subgroup variance estimates.

In DRG #162, there is relatively little variability in mean direct costs in complexity levels 1 and 2 (CV .12 and .25) but substantial heterogeneity in level 3 (CV .63). Once again the between-group variance estimate appears to be insignificant in relation to within-group variability. Possible reasons for failure of the complexity index to discriminate among subgroups in DRGs #105 and #222 were given in section 4.1.5 (p. 116), and appear also to be related more to inconsistencies in length of stay than to similarities in actual need for direct nursing care.

As demonstrated in Table 28 (p. 233), age appears not to be a relevant factor in predicting the mean cost of nursing care in DRGs #088 (COPD), #148 (Major Intestinal Op), #162 (Hernia Op), #209 (Major Joint Op) and #335 (Male Pelvic Op). In three of these diagnostic groups (#088, #209 and #335) the mean age is 63, 66 and 70 respectively and the point at which the age groups were subdivided may well mask the influence of more advanced age.

It appears that age greater than 50 years may be associated with higher nursing costs for DRGs #355 (Hysterectomy), #222 (Knee Op), #105 (Cardiac Valve Op) and #001 (Craniotomy), although the most highly significant age subdivision in DRG #001 is at 70 years.

Age 65 years seems to be the most critical determinant of higher mean nursing costs only for DRGs #107 (Coronary Bypass) and #122 (AMI), and in the latter, age 70 years appears somewhat more significant.

While age certainly seems to be a useful predictor of higher consumption of nursing resources, the belief that 65 years is a critical stage at which differences begin to appear is not supported in this research. For some DRGs the mean costs of nursing care begin to rise at an earlier age, while for others advancing age may only be important at a later stage, if at all.

Influence of Type of Admission and Condition of Discharge

Table 29 (Appendix G, p. 234) demonstrates that at the .05 level of significance urgent admissions have an impact on the direct costs of care only for DRGs #088 (COPD), #122 (AMI), #162 (Hernia Op), #209 (Joint Op) and #335 (Male Pelvic Op). When only per diem nursing costs are considered, all DRGs except #105 (Cardiac Valve Op), #107 (Coronary Bypass), #148 (Major Intestinal Op) and #355 (Hysterectomy) have significantly higher mean costs for emergency admissions. This implies that the stay patterns of urgent admissions is not substantially different from that of others.

Condition at discharge has a significant influence on the mean direct costs of care for all DRGs except #148 (Major Int Op), #209 (Major Joint Op), #355 (Hysterectomy) and #430 (Psychoses). Of these only DRG #355 (in which there were no deaths and only one transfer), shows no statistically significant difference in mean direct or per diem nursing costs across the types of discharge. A sizeable change in the proportion of deaths or transfers in the majority of diagnostic categories could therefore be expected to result in nursing budget variances.

4.2.4 Assessing Within Subgroup Differences Across DRGs

Hypothesis #3

Ho: There are no differences in mean nursing costs across diagnostic groups within complexity levels.

A relevant issue addressed in this research is whether patients who are categorized into a given complexity level utilize on average similar amounts of nursing resources irrespective of diagnosis. If they do, complexity related variances in the nursing budget can probably be adequately explained by monitoring changes in the proportion of patient types classified daily for staffing purposes. Since lengths of stay vary significantly across diagnoses, direct mean costs of care are also very likely different among the DRGs in any given level of complexity. When length of stay is held constant, significant differences in mean direct nursing costs across DRGs should reflect true variation in resource consumption, related to diagnosis.

Table 23 (Appendix G, p. 228) demonstrates that differences in mean direct, total, and per diem costs are highly significant for all complexity levels *except subgroup 4*. It seems that at the highest complexity level, patients are very similar with respect to their utilization of nursing services. It should be noted, however, that the seven DRGs with level 4 patients (#001, 088, 105, 107, 148, 209, 430) are the top ranked DRGs in terms of complexity, when DRG #458 is excluded (p. 107). It may be that patients at lower complexity levels would also be more similar in resource consumption if only DRGs of like complexity were included in the ANOVA model. To test this assumption, two separate clusters of DRGs were selected for analysis. In the first, DRGs #001 (Craniotomy), #148 (Major Intestinal Op) and #430 (Psychoses) were entered as the independent variable in the ANOVA model. These three DRGs have the highest mean direct nursing costs *and* the longest average lengths of stay of all DRGs included in statistical analysis. Next, DRGs

#105 (Cardiac Valve Op), #107 (Coronary Bypass) and #122 (AMI), which have similar lengths of stay but differ in terms of costliness (they rank fourth, fifth and eighth in mean direct nursing costs) were tested together.

Table 31 (p. 236) demonstrates that no statistically significant differences in mean direct costs are found at any of the complexity levels for the first cluster of DRGs (#001, #148, #430), but differences in mean total and per diem costs remain in at least one of the complexity subgroups across the three diagnoses. In the second cluster of DRGs (#105, #107 & #122) only complexity subgroup 4 maintains a lack of statistical significance consistently across diagnoses. The results show conclusively that the "average" patient in one DRG is not necessarily similar to the average patient in another. A level 2 patient in one DRG requires different amounts of care than the level 2 patient in another DRG, even when differences in length of stay are taken into account.

It is interesting to compare the relative differences in mean direct costs across all DRGs for each of the four complexity levels (Table 23, p. 228). The mean costs of each successively higher complexity level represent .5, .8, 1.5 and 3.4 respectively of the mean ($1,408.43) direct cost for the sample of patients. The level 1 mean is about half as large as the level 2 mean, which is again half as large as level 3's mean and so on. These weights are somewhat similar to the Medicus classification coefficients (.5, 1.0, 2.5, & 5.0) used to transform each patient's daily classification scores to a total cost of care. The complexity index developed for this research understates to some extent the relative differences in intensity of need implied by the classification coefficients. Nonetheless, in the process of aggregating patients into subgroups, the complexity index appears to have been successful in closely reflecting stay specific relative differences in resource consumption among the groups.

4.3 Summary

The analysis of data demonstrates that nursing budget variances can be more clearly understood when elements of two patient classification systems, one nursing and the other medical, are integrated. Nursing costs were shown to differ substantially across DRGs, and considerable variance in nursing complexity was found within all diagnostic categories. This research lends support to the findings of others who have confirmed that on their own, DRGs are poor predictors of nursing resource need (Giovannetti et al, 1984; Mitchell et al, 1984; Sovie et al, 1985).

In addition to corroborating much recent evidence of the unsuitability of DRGs from a reimbursement perspective (Bergen & Roth, 1984; Butler & Bentley, 1982; Horn, 1983), this study extends current knowledge about case based nursing costs in two important ways.

Firstly, it has been shown that nursing classification systems can be used effectively to capture stay specific differences in nursing complexity among patients grouped in the same diagnostic category. This allows nursing costs to be analyzed not only on the basis of patient mix and volume but, perhaps more importantly, according to policy decisions or individual factors which affect nursing care needs (i.e. complexity).

Secondly, this study answers to some extent a question recently asked about the potential relationship between length of stay and heterogeneity of nursing care needs within DRGs (Sovie et al, 1985). Little difference in length of stay patterns was found within DRGs among patients who differed significantly in use of nursing resources across complexity subgroups. Other factors, including age, route of admission and condition at discharge were found to have a considerable influence on nursing care costs in most DRGs. A possible correlation between these variables and prolonged length of stay was not addressed in this research, but others have found that neither age (McClain & Selhat, 1984; Sovie et al, 1985) nor route of admission (McClain & Selhat, 1984) can reliably forecast length of stay. The results of this study suggest, however, that they may be useful predictors of nursing care requirements. Further study of the correlation between these variables and complexity of nursing care need appears warranted.

The results of this research strongly support the value of the complexity index as a tool for analyzing nursing department costs.

5. SUMMARY AND RECOMMENDATIONS

In this final chapter a summary of the study is presented. Major findings are highlighted and recommendations for further research are proposed.

5.1 Introduction

The cost of providing nursing care to the in-patient population represents a significant proportion of a hospital's total operating budget. To achieve control of nursing department expenditures, it is essential that input costs, which reflect the quantity of nursing care provided, be analyzed in relation to patient mix and volume (output). In the absence of this measure of efficiency, the cost implications of differences in case mix over different time periods cannot be reliably estimated (Hundert & Stewart, 1984).

Nurse managers are well aware that gross measures of output, such as hours of nursing care per patient day, are inadequate for purposes of planning, budgeting, and management control. In the past decade, patient classification systems have become increasingly more popular as a means of identifying and quantifying patient needs, in an effort to contain costs and rationalize nurse staffing.

Traditionally, however, patient classification systems in nursing have been used to categorize patients on a day to day basis, to adjust nurse staffing levels according to the identified care needs of the in-patient population. Although this allows nurse managers to explain cost variances on the basis of changes in overall intensity levels within an institution over a specified time period, it nonetheless focuses on inputs (nurse hours required) and does not lend itself to an assessment of the relationship between nursing resource use, patient type and nursing care costs. It does not explain whether changing intensity levels reflect a change in case mix or changes in case intricacy, related to factors such as an aging population or advances in medical technology, for a given case mix.

Finally, since hospitals adapt patient classification systems to suit their own unique situation, the measurement of nursing productivity on the basis of hospital specific intensity levels does not lend itself to inter-hospital comparisons, which is a distinct disadvantage from a cost analysis perspective.

It is well recognized that a methodology is needed to overcome current deficiencies in approaches to planning, budgeting and cost control by hospital managers in Canada (de Mora, 1984; Hundert & Stewart, 1984). A relationship must be established between case mix, resource use and hospital costs, but case-based assessment of hospital costs is seriously impeded in Canada by the lack of patient specific data in the cost accounting system. Patient classification systems in nursing can, however, be readily adapted to the measurement of patient specific utilization of nursing resources, which represent a considerable proportion of total resource use. The development of an appropriate methodology for allocating nursing resources could well pave the way for developing other processes which would allow total hospital costs to be better understood in relation to case mix.

Given the wide variety of patient diagnoses treated in most hospitals, meaningful analysis of nursing costs requires that patients be grouped into manageable numbers of diagnostic categories. The Diagnosis Related Groups (DRG) case mix measure provides nurse managers with an opportunity for detailed analysis of nursing costs by allowing them to relate the use of nursing resources directly to hospital output. The allocation of nursing costs in the DRG system, however, requires that adjustments be made for differing levels of nursing care needs among patients grouped in the same diagnostic category, since that is not a feature of the case mix measure.

The present study was an attempt to develop a methodology for analyzing nursing costs which reflects the nature and behaviour of hospital case mix. An analysis was made of how the nursing budget might vary in relation to the *mix and complexity* of cases treated. Case mix refers to the categorization of patients into diagnosis related groups (DRGs), a classification system which reflects total hospital resource use. Complexity was defined as the total quantity of nursing resources required to provide care to a patient during the course of hospitalization (Luke, 1979). The Medicus Patient Classification Tool was used to quantify nursing resources required for each day of stay and to assign patients to a complexity subgroup on the basis of a stay specific representative score.

5.2 Study Design

Discharge abstracts coded into appropriate Diagnosis Related Groups (DRGs) for a portion of the patient caseload from a large tertiary care hospital in Alberta were used to develop a data base for costing nursing services by complexity adjusted diagnostic categories. At the time of data collection (July and August, 1984), only discharge data for the period October, 1983 through March, 1984 were available on computer print-outs on which all pertinent information was already coded into DRGs. From the list of available diagnostic groups, thirteen were arbitrarily selected for inclusion in the study. Selection criteria ensured that DRGs reflecting variable resource use were included and that the proportion of cases within each DRG was sufficient to permit meaningful statistical manipulation. The patient sample (1,434 cases) represents approximately nine percent of all hospital discharges from the hospital during the six month study period.

In addition to assessing the impact of case mix and case complexity on nursing department costs, an attempt was made to identify relevant patient attributes which significantly affect nursing resource use and hence costs. Data from the discharge abstract which were included in the study therefore include diagnosis (DRG), age, route of admission (e.g. emergency or elective) and condition at time of discharge (e.g. alive or deceased). Sex was recorded on the data collection form but was not included as a separate variable in data analysis.

All analyses of data were performed using the Statistical Analysis Systems (SAS) computer program.

5.3 Methodology

The Medicus Patient Classification Tool was used to quantify nursing care requirements for each patient throughout the period of hospitalization. Two categories of nursing costs were defined. Direct nursing care denotes that portion of the nursing department's activities accounted for directly by the patient classification tool. To obtain the daily *direct* nursing care cost, an adjusted average hourly wage ($17.00) was multiplied by the classification tool's assigned hours. To this was added a fixed cost ($54.00), allocated to each patient for every day of stay, to arrive at the daily *total* cost of care. The fixed cost reflects the expense of providing nursing services, including administration, research and staff education, which are not accounted for through the classification system.

For each patient, daily direct and total nursing costs were summed over the entire course of hospitalization, to provide stay specific nursing costs.

The median patient classification score was then used to assign each patient to a complexity subgroup within a DRG.

For each DRG, outliers were identified and excluded from the data set since they are atypically expensive and would exert an inappropriate influence on the group mean cost. Since the setting for this study was a Canadian hospital, the HMRI trim point was used to exclude outliers.

Mean costs for each diagnostic category and for each complexity subgroup within DRGs were computed. Within DRGs mean nursing costs associated with age, type of admission and condition at discharge were also calculated.

Analysis of variance was then used to determine whether significant differences in mean nursing costs exist across DRGs and, within each DRG, across complexity levels. Analysis of variance was also used to determine the extent of significant differences in mean nursing costs associated with selected patient related attributes.

5.4 Study Results

Substantial variation in mean total and direct nursing costs was found among and within the selected Diagnosis Related Groups included in this study. The results appear to invalidate any cost allocation methodology which assumes that patients within a diagnostic group are relatively homogeneous with respect to nursing resource use. The failure of DRGs to adequately account for variance in nursing complexity is clearly evident from the work of other researchers who have costed nursing services by diagnostic categories (Giovannetti et al, 1984; Mitchell et al, 1984; Sovie et al, 1985).

Other major findings of this study are listed below.

1. The DRGs associated with the highest overall nursing costs and with the highest nursing cost per case are not surprisingly, those with the longest average lengths of stay. In this study, three of the DRGs with the highest mean costs (#001, #148 & #458) were also among the top five diagnostic categories with the highest costs per patient day (#001, #105, #107, #148, #458).

2. Substantial variation in nursing resource use exists within diagnostic categories among patients assigned to representative complexity subgroups. It is evident that there is considerable fluctuation in the intensity of nursing care required on a day to day basis by patients whose stay specific demand for nursing resources is similar. Despite this variability within complexity subgroups, statistically significant differences in mean direct nursing costs were found across the subgroups for all DRGs except #105 (Cardiac Valve Op), #148 (Major Intestinal Op), #162 (Hernia Op) and #222 (Knee Op).

3. A surprising finding of this study was the similarity in average lengths of stay across complexity subgroups within all DRGs. It had been assumed that average length of stay would increase at each

successively higher complexity level, but this was not found in most DRGs. The only DRGs in which statistically significant differences in length of stay were found across complexity subgroups (#162 and #222) had the longest average stay associated with one of the less complex levels.

4. When length of stay was controlled for, statistically significant differences in mean per diem nursing costs were found across complexity subgroups in all DRGs. This suggests that the complexity index developed in this study is highly effective in discriminating between groups of patients within DRGs who differ in their utilization of nursing resources. Further inquiry would be needed to determine why length of stay patterns are so similar among patients who truly differ in their need for nursing care.

5. In some DRGs (#001, #088, #209, #335 and #458) increments in mean nursing costs from one complexity level to another are much more substantial than in others. Volume changes at the costliest level of complexity in these DRGs would be associated with far greater variances in the nursing budget than a similar increase in complexity in other DRGs.

6. Statistically significant differences in mean direct and per diem nursing costs were found for all complexity subgroups across DRGs, except subgroup four. It appears that at the highest complexity level, diagnosis does not play a major role in determining the need for nursing resources. It is nonetheless apparent that to achieve a

full understanding of the behavior of nursing costs, it is necessary to monitor changes in complexity levels in relation to case mix. Since mean nursing costs differ substantially across diagnostic groups for most complexity levels, volume increases in a given complexity level would have a far greater impact on the nursing budget for some DRGs than for others.

7. The complexity index developed in this study used the median classification to assign patients to a complexity level. It has been shown to be highly successful in creating sub-groups which differ significantly in stay specific nursing resource consumption. Furthermore, relative differences in mean direct nursing costs among the subgroups adequately reflect empirically derived differences in the burden which each of the patient types places on the nursing staff, exemplified by the classification coefficients or weights.

8. Advancing age is associated with somewhat higher mean direct nursing costs in most DRGs, but statistically significant differences were found in only seven of the twelve DRGs included in significance testing. Age 50 years was the critical point at which meaningful differences in mean direct nursing costs were found for four of these seven DRGs. For DRG #001, mean direct nursing costs were twice as high for patients aged 60 years or more, and four times as high when the patient groups were subdivided at under and over age 70 years. In this DRG more than in any other, an increase in the proportion of patients over the age of 60 (and particularly over the age of 70) would have a noticeable effect on the nursing budget.

9. Emergency admission was shown to have a statistically significant effect on mean direct nursing costs in only five (#088, #122, #162, #209, #335) of the twelve DRGs included in significance testing. When mean per diem nursing costs were entered as the dependent variable, only five DRGs (#105, #107, #122, #148, #355) failed to demonstrate significant differences in mean nursing costs. This is an indication that although patients requiring urgent admission tend to consume more direct nursing resources than elective admissions, the length of stay patterns of the two groups are very similar. This latter finding is consistent with previous research (McClain & Selhat, 1984).

10. Condition at discharge was shown to have a statistically significant influence on mean direct nursing costs for all DRGs except #148, #209, #355 and #430. In DRGs #001 and #088, the mean nursing costs of the deceased group were more than twice as high as for those discharged to their own homes. Proportional increases in the number of deaths in these DRGs would have a greater impact on the nursing department budget than similar increases in most other DRGs.

5.5 Conclusions

The main purpose of this study was to establish a relationship between case mix, nursing resource use and nursing costs, in order that the impact of changes on case mix and/or case complexity might be assessed. The results have shown conclusively that the quality of information available to managers concerning the behavior of nursing costs is greatly enhanced when data derived from patient classification for staffing purposes is merged with case mix information. This is not a unique finding. Although very few studies of the relationship between case mix and nursing classification data have been reported in the literature to date, other researchers have shown that nursing care costs vary drastically across DRGs (Giovannetti et al, 1984; Mitchell et al, 1984). In their study, Mitchell et al (1984) used a patient classification system to measure the range of costs and average nursing costs within DRGs, and demonstrated that nursing resource use for different DRGs varied considerably. Two of the DRGs for which they provided results (#122 and #209) were also included in this study. The direct mean nursing costs reported in their study were $1,109 (N = 12) and $1,368 (N = 32) for DRGs #122 and #209 respectively. These are similar to the direct mean nursing costs obtained in this study - $1,225 (N = 85) and $1,617 (N = 137) for DRGs #122 and #209 respectively. The mean hours of nursing care required by patients in the two studies were also quite similar. In the Mitchell et al (1984) study these were 68 hours and 88 hours for DRGs #122 and #209 respectively, while the respective figures in this study were 72 and 95 hours.

Giovannetti et al (1984) report the mean direct nursing care costs for two of the DRGs (#088 and #355) included in this study. These are $482 and $257 for DRGs #088 and #355 respectively, which differs substantially from the mean direct nursing care costs calculated for those two DRGs in this study ($1,345 and $603 for DRGs #088 and #355). The average length of stay (LOS) of patients in the respective DRGs also differs considerably in the two studies. While the mean LOS was 9.9 days and 6.7 days for DRGs #088 and #355 in the Giovannetti et al study, comparable LOS was 14.1 and 8.6 days respectively in the present study, which could explain a substantial amount of the difference in costs.

The two studies referred to above were conducted in American hospitals. Neither group of researchers reported costs on the basis of complexity subgroups, such that detailed comparison of results among the studies is not possible. Furthermore, differences in the definition of direct nursing care impede comparability of results among other studies which have focused on costing nursing services by diagnostic categories (Sovie et al, 1985).

There is no report of any Canadian research in which an attempt has been made to cost nursing services by DRG or HMRI diagnostic category. There is an obvious need for further research of this type to be carried out before it can be conclusively stated that the findings reported in this study reflect the actual behaviour of nursing costs in this country. The research has nonetheless demonstrated without any doubt the value and importance of analyzing nursing costs in relation to the patient's medical condition. It has been shown that although patient related variables such as age, route of admission, and criticalness of illness (i.e. risk of death) influence the costs of providing nursing care, their effect is more marked for some diagnoses than for others. Furthermore, none of these variables is as consistently effective in explaining differences in nursing costs among patients as is diagnosis.

Perhaps the most significant aspect of this study has been the demonstration that it is insufficient to merely monitor changes in nursing intensity levels (measured through daily classification of patients) to fully understand variances in the budget. Patients differ in their use of nursing resources within diagnostic categories, and across diagnoses even when level of complexity has been adjusted. The search for a methodology for allocating nursing costs requires extensive analysis of the need for nursing care among patients differing in complexity across the full spectrum of DRGs in the classifications system. This research has been but a beginning attempt at trying to identify some of the causes of major variances in the nursing budget.

5.6 Recommendations

The following recommendations ensue from the research described in this report.

1. Managers should ensure that daily classification scores obtained on all patients become a part of the permanent medical record, so that data might be readily available should hospitals wish to analyze stay specific nursing costs.

2. This study should be replicated in hospitals of similar and of different size and role, to provide a better understanding of how nursing costs vary in relation to differences in inter-hospital case mix and/or case complexity.

3. The median classification score was shown to be successful in creating four distinct groups of patients within DRGs who differ significantly in their need for nursing care. Since this ordinal approach to forming subgroups merely reflects magnitude differences across the groups, comparability among hospitals using the same number of categories should be possible, irrespective of the nursing classification system in use. This would allow hospitals to be compared on the basis of both case mix and nursing complexity, which is a distinct advantage from a cost analysis perspective. The validity of this assumption should be tested through further research.

4. It appears that DRGs, despite their obvious inadequacies from a reimbursement perspective, are a powerful tool for management control. More Canadian hospitals should consider using the HMRI or DRG case mix measures as a method for analyzing how input costs might vary in relation to case mix.

5. More research into the relationship between length of stay and nursing resource use is needed to provide a better understanding of the factors which contribute to unexpected similarities in stay patterns among patients who differ significantly in terms of complexity.

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APPENDIX A

DATA COLLECTION FORM

DRG / Patient Classification Study

A. Patient's Name: ____________________

Hospital Identification Number 1 ☐☐☐☐☐☐☐

Sex: (1) Male (2) Female 8 ☐

Age: 9 ☐☐

DRG group 11 ☐☐☐

Primary diagnosis 14 ☐☐☐☐☐

Secondary diagnosis 19 ☐☐☐☐☐

Surgical Procedure 24 ☐☐☐☐☐

Complications 29 ☐☐☐☐☐

Type of Admission 34 ☐

Condition at discharge 35 ☐

B. Patient Unit: ________ ________ ________

yr. mo day

Admission Date: 36 ☐☐☐☐☐☐

Discharge Date: 42 ☐☐☐☐☐☐

C. Patient classification by day of stay:

48 ☐	55 ☐	62 ☐	69 ☐	76 ☐	83 ☐	90 ☐
☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐

DRG / Patient Classification Study

A. Patient's Name: ______________________________ ☐☐☐☐☐☐

C. Patient classification by day of stay:

97 ☐	104 ☐	111 ☐	118 ☐	125 ☐	132 ☐	139 ☐	146 ☐	153 ☐	160 ☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
167 ☐	174 ☐	181 ☐	188 ☐	195 ☐	202 ☐	209 ☐	216 ☐	223 ☐	230 ☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
237 ☐	244 ☐	251 ☐	258 ☐	265 ☐	272 ☐	279 ☐	286 ☐	293 ☐	300 ☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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APPENDIX B

MEDICUS PATIENT CLASSIFICATION TOOL

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DATE:

PATIENT CLASSIFICATION FORM

UNIT:	CONDITIONS													BASIC CARE							THERAPEUTIC NEEDS													
PATIENTS NAME	Admission or Transfer in	Discharge or Transfer Out	Less Than 2Years Old	2 - 6 Yrs. Old	Unconscious	Confused/Retrd or Disoriented	Blind or Nearly Blind	Isolation/Isolette	Partial Immobility	Complete Immobility	Respirator	Tracheostomy	Incontinent/ Diaphoretic	Up Ad Lib	Up With Assistance	Bed Rest	Bath With Assistance	Bath Total	Assistance With Oral/Tube Feed	Total Oral/Tube Feed	I & O	Specimen Collection	Tube Care	Extensive Skin Care	Wound and /or Simple Skin Care	Oxygen Therapy	Monitoring	Vital Signs Q2 Hrs. or More Often	IV's and Site Care	Special Teaching Needs	Special Emotional Needs	Prep'd For Test and/or Proc.	Total Points	Patient Type

Form Reviewed By: ______________________ R.N. Please indicate time form completed ______________________

3830-04140-30JUNE82-STORES

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MEDICINE – DEFINITIONS OF INDICATORS

Admission or Transfer in: Place a mark if the patient has already arrived on the unit during the day shift, or if it is known that a patient is to arrive on the unit during the day shift. If indicators of the patient to arrive are known, then they should be recorded. This may apply to patient care areas that are receiving patients from the Operating Room, PAR, or from Surgical Intensive Care.

Discharge or Transfer Out: Mark this indicator if patient is certain to be discharged or transferred from the unit during the day shift.

Less than 2 Years Old: Self explanatory. Refers to the needs related to growth and development.

2 – 6 Years Old: Self explanatory. Refers to the needs related to growth and development.

Unconscious: Applies to the patient who is unconscious. Does not include lethargic or stuporous patients. The patient's basic care should not be listed as up ad lib or up with assistance. Special Teaching Needs and Special Emotional Needs would also be erroneous in this situation unless directed toward the family.

Confused, Retarded or Disoriented: Applies to the patients who are confused (unable to follow commands, care for self, etc), disoriented (as to time and place) or retarded (mental age significantly below chronologic age). Does not apply to the unconscious patient.

Blind or Nearly Blind: Place a mark if patient relies on nursing for needs due to blindness. This should also be marked for the patient with eye patches which result in the patient requiring nursing assistance; e.g., post-op cataract. Do not mark if patient is unconscious.

Isolation/Isolette: Applies to the patient requiring medical aseptic and protective care. Also refers to the infant requiring a controlled environment; e.g., incubator.

Partial Immobility: Place a mark for patients partially immobilized as a result of IV's, cast, splint, restraints, arthritis, etc., which leads to dependence on nursing for assistance with routine activities. Do not routinely check for infants.

Complete Immobility: Place a mark for the patient with a high degree of immobility or the patient with complete immobility. These are patients who are incapable of participation in most activities, such as turning and moving. Do not routinely check for infants. Examples are the quadraplegic or unconscious patient.

Respirator: If this is checked, oxygen therapy category must be checked.

Tracheostomy: Place a mark for any patient who has a tracheostomy or an endotrach. Also mark tube care, under therapeutic needs, if patient relies upon nursing for care of tube.

Incontinent of Bowel or Bladder/Diaphoretic: Refers to patient who is incontinent of urine or feces. Does not need to be marked if patient has indwelling catheter. Also applies to patient with extreme diaphoresis or patient under high humidity tent who requires linen to be changed frequently (at least two times per shift). Does not routinely apply to infants who are not yet toilet trained.

The next three indicators: Up Ad Lib; Up With Assistance; and Bed Rest, refer to the activity level of a patient. One of these three indicators is to be checked for each patient classified.

Up Ad Lib: Self explanatory. Up With Assistance or Bed Rest cannot be checked if Up Ad Lib is checked.

Up With Assistance: Self explanatory. Bed Rest or Up Ad Lib cannot be checked if Up With Assistance is checked.

Bed Rest: Check if patient is restricted to bed without bathroom privileges. Includes all infants. Up Ad Lib or Up With Assistance cannot be checked if Bed Rest is checked.

Bath With Assistance: Check for patient needing help with (1) Setting up bath equipment and/or (2) washing small areas of body; e.g., back. Also includes patient needing supervision during bath; e.g., child in tub.

Bath Total: Includes patients needing entire bath or patients who are only able to bathe small areas of the body; e.g., face, hands, and genitalia.

Oral/Tube Feed With Assistance: Place a mark if patient requires tray or tube feeding to be set up by nursing personnel. Patient is then capable of feeding self or administering own tube feeding with minimal supervision.

Oral/Tube Feed Total: Place check mark if patient is unable to feed self. It is also appropriate to check this column if patient requires constant supervision during the meal.

Intake and Output: Place a mark if patient requires recording of Intake or Output, or both.

Specimen Collection: Place a mark if patient requires specimen collection by nursing, whether the specimen is sent to a laboratory or used on the unit. (e.g., urine for specific gravity or fractional urines). This column is not marked if specimen is not obtained by unit personnel (e.g., blood work drawn by the lab).

Tube Care: Place a mark if patient needs assistance with tubes; e.g., suction for trach, cleaning trach tube, irrigating and aspirating nasogastric tube, irrigating Foley catheters, or pericare for patients with Foley catheters.

Extensive Wound and/or Skin Care: This indicator includes those patients with extensive burns, excoriations, or dermatological problems requiring extensive care.

Wound and/or Simple Skin Care: This indicator includes those patients requiring close observation or basic skin care of wound or operative site or those patients prone to decubiti who are receiving preventative skin care. IV site care is not included. Do not check for routine A.M. and/or P.M. care.

Oxygen Therapy: Place a mark if patient is to receive any oxygen therapy, heated aerosol, high humidity tent, IPPB, nasal O_2, etc. This applies if nursing must be aware of, or directly responsible for, the oxygen therapy.

Monitoring: Refers to patients being mechanically monitored as well as those patients requiring frequent visual observations Q15 minutes or more often (e.g., psychiatric or retarded patient, patient being weaned from a ventilator, patients on medicated IV drips which require very close monitoring). Do not routinely check for infants and children.

Vital Signs Q 2 Hours or More Often: Place a mark for patients requiring monitoring of vital signs, Q 2 hours or more often. Vital signs include, TPR, BP, CVP monitoring, neuro signs, and extremity pulses, etc.

IV's and Site Care: Self explanatory. Includes A-V shunts, T.P.N., arterial and central lines, heparin locks, pacemakers.

Special Teaching Needs: Place a mark if patient and/or family requires special instructions; e.g., diabetic teaching, pre-op teaching. This does not include routine admission instructions, familiarization with environment, or instructions for laboratory tests unless the patient and/or the family exhibit difficulties in following instructions.

Special Emotional Needs: Place a mark for patients and for families needing additional emotional support because they are experiencing stress beyond the usual stress of hospitalization, are having difficulty coping, are unable to cope, or are exhibiting inappropriate behavior (e.g., expressing suicidal ideations, highly withdrawn, aggressiveness). If this item is checked, the emotional needs should be documented in Nursing Assessment and Plan.

Prepared for Tests and/or Procedures: Place a mark if patient requires preparation by nursing during this shift for a test or a procedure; e.g., surgery, preparation for endoscopy.

APPENDIX C

LENGTH OF STAY AND COST RANGES BY DRG SUBGROUPS

TABLE 11 LENGTH OF STAY AND COST RANGES BY DRG SUBGROUPS

DRG		TOTAL COSTS		LOS RANGE (days)	DIRECT COSTS
	sg	COST RANGE	PER DIEM		COST RANGE
001	1	335.00 - 10,385.30	83.75 - 162.38	4 - 83	119.00 - 5,903.25
	2	513.50 - 9,811.75	105.50 - 205.79	4 - 93	297.50 - 4,828.00
	3	316.25 - 32,007.50	155.15 - 296.49	2 - 126	208.25 - 25,797.50
	4	1,278.50 - 16,088.50	319.63 - 436.50	4 - 39	1,062.50 - 13,982.50
088	1	335.00 - 3,493.25	77.14 - 136.78	4 - 41	119.00 to 1,904.00
	2	227.00 - 4,299.75	98.63 - 150.12	2 - 35	119.00 - 2,409.75
	3	811.00 - 10,478.00	156.27 - 322.08	4 - 53	565.25 - 7,616.00
	4	639.25 - 7,062.75	319.63 - 336.32	2 - 21	531.25 - 5,928.75
105	1	3,168.25	109.25	29	1,602.25
	2	663.50 - 6,240.50	137.71 - 228.60	3 - 43	501.50 - 3,918.50
	3	752.75 - 7,198.00	175.13 - 287.92	3 - 34	590.75 - 5,848.00
	4	2,385.25	397.54	6	2,061.25
107	1				
	2	1,456.75 - 4,655.75	128.38 - 231.08	8 - 29	862.75 - 3,089.75
	3	1,302.75 - 7,383.00	162.18 - 268.09	5 - 30	1,032.75 - 5,763.00
	4	1,393.25 - 7,160.00	283.50 - 397.78	4 - 18	1,177.25 - 6,188.00
122	1	937.75	117.22	8	505.75
	2	227.00 - 2,870.50	98.63 - 170.73	2 - 19	119.00 - 1,,844.50
	3	202.75 - 5,571.00	158.13 - 265.29	1 - 33	148.75 - 4,437.00
	4				
148	1				
	2	1,259.50 - 8,804.75	126.72 - 169.32	9 - 52	773.50 - 5,996.75
	3	1,013.75 - 16,084.50	150.68 - 305.05	5 - 83	743.75 - 11,602.5
	4	4,727.00	328.62	13	3,570.00
	5	5,350.50	764.36	7	4,972.50
162	1	454.00 - 764.75	105.00 - 113.50	4 - 7	238.00 - 386.75
	2	286.50 - 1,056.75	98.63 - 143.25	2 - 9	178.50 - 624.75
	3	316.25 - 1,127.25	148.21 - 202.75	2 - 6	208.25 - 803.25
209	1				
	2	429.75 - 6,591.75	109.25 - 158.94	3 - 51	267.75 - 3,837.75
	3	835.25 - 16,671.00	154.41 - 249.50	5 - 83	565.25 - 12,189.00
	4	1,917.75 - 13,891.80	319.63 - 369.71	6 - 42	1,593.75 - 11,623.80
222	1	167.50	83.75	2	59.50
	2	113.50 - 1,946.00	73.83 - 151.75	1 - 17	59.50 - 1,190.00
	3	202.75 - 1,240.75	143.25 - 202.75	1 - 7	148.75 - 862.75

TABLE 11 LENGTH OF STAY AND COST RANGES BY DRG SUBGROUPS

DRG	sg	TOTAL COSTS		LOS	DIRECT COSTS
		COST RANGE	PER DIEM	RANGE (days)	COST RANGE
335	1	616.00 - 4,088.25	88.00 - 124.66	6 - 41	238.00 - 1,874.25
	2	794.50 - 3,175.75	102.34 - 148.66	7 - 23	386.75 - 1,933.75
	3	1,892.00 - 4,372.50	145.54 - 208.21	11- 26	1,190.00 - 3,238.50
355	1	740.50 - 1,589.00	102.34 - 136.64	6 - 14	386.75 - 833.00
	2	597.25 - 2,208.25	113.50 - 195.95	5 - 15	327.25 - 1,398.25
	3	1,092.00 - 1,324.50	156.00 - 165.56	7 - 8	714.00 - 892.50
430	1	943.25 - 10,653.80	93.39 - 134.75	7 - 27	505.75 - 4,551.75
	2	883.75 - 15,966.50	105.24 - 197.65	7 - 106	505.75 - 10,242.50
	3	316.25 - 15,238.50	148.21 - 300.03	2 - 74	208.25 - 12,095.50
	4	873.00 - 15,823.80	358.58 - 436.50	2 - 40	765.00 - 13,663.80
458	1	2,210.50	110.53	20	1,130.50
	2	1,762.00 - 8,326.00	117.47 - 189.23	15- 44	952.00 - 5,950.00
	3	2,570.75 - 15,099.50	180.44 - 329.06	14- 55	1,814.75 - 12,129.50
	4	13,802.50 - 26,863.80	328.63 - 413.29	42- 65	11,534.50 - 23,353.80

APPENDIX D

GROUP AND SUBGROUP TOTAL AND DIRECT NURSING COST AND LENGTH OF STAY MEANS AND COEFFICIENTS OF VARIATION

TABLE 12

MEAN NURSING COST (TOTAL) AND DEGREE OF VARIABILITY DIAGNOSIS RELATED GROUPS

Group		001	088	105	107	122	148	162	209	222	335	355	430	458
Total	N	89	106	63	128	85	68	80	137	219	115	151	130	32
	Mean	4,136.96	2,103.35	2,666.94	2,359.88	1,838.16	4,127.30	635.57	2,515.96	583.57	1,398.69	1,067.27	4,337.83	6,322.96
	C.V.	1.26	.78	.56	.36	.58	.72	.27	.86	.53	.54	.23	.84	.80
1	N	24	18	1		1		18		1	79	73	14	1
	Mean	2,075.23	1,282.99	3,168.25		937.75		614.03		167.50	1,249.97	1,024.56	2,664.13	2,210.50
	C.V.	.92	.74	-		-		.14		-	.52	.17	.92	
2	N	29	40	33	83	46	16	57	104	137	32	75	62	8
	Mean	2,492.27	1,685.11	2,331.04	2,238.61	1,526.13	2,970.63	644.54	2,232.85	625.29	1,545.95	1,104.36	3,935.53	3,263.34
	C.V.	.83	.62	.48	.25		.56	.26	.51	.55	.41	.26	.76	.72
3	N	29	45	28	42	38	50	5	30	81	4	3	50	21
	Mean	6,882.35	2,691.61	3,054.97	2,469.95	2,239.58	4,470.07	610.90	3,049.50	518.16	3,157.88	1,179.42	5,170.63	6,350.06
	C.V.	1.09	.71	.59	.40	.60	.73	.61	1.14	.43	.41	.11	.80	.48
4	N	7	3	1	3		1		3				4	2
	Mean	6,645.64	3,778.25	2,385.25	4,174.08		4,272.00		6,995.17				6,021.56	20,333.10
	C.V.	.75	.85	-	.69		-		.89				1.16	.45
5	N						1							
	Mean						5,350.50							

TABLE 13

MEAN PER DIEM NURSING COST (TOTAL) AND DEGREE OF VARIABILITY
DIAGNOSIS RELATED GROUPS

Group		001	088	105	107	122	148	162	209	222	335	355	430	458
Total	N Mean C.V.	89 180.18 .46	106 149.45 .37	63 207.97 .21	128 201.55 .17	85 157.84 .17	68 188.94 .43	80 124.85 .14	137 151.37 .24	219 145.51 .10	145 111.89 .16	151 124.73 .10	130 163.75 .36	32 209.72 .34
1	N Mean C.V.	24 120.16 .19	18 93.36 .15	1 109.25 -		1 117.22 -		18 110.93 .03		1 83.75 -	79 103.66 .06	73 117.69 .05	14 107.32 .11	1 110.53 -
2	N Mean C.V.	29 144.34 .19	40 117.41 .12	33 188.16 .13	83 185.66 .10	46 142.32 .10	16 143.67 .09	57 125.19 .09	104 137.25 .07	137 132.44 .10	32 123.93 .10	75 130.14 .09	62 138.25 .14	8 135.36 .17
3	N Mean C.V.	29 212.14 .19	45 188.43 .17	28 228.08 .14	42 222.84 .10	38 177.69 .14	50 189.13 .19	5 171.02 .14	30 181.44 .13	81 168.38 .09	4 178.07 .17	3 160.60 .03	50 192.05 .20	21 227.42 .19
4	N Mean C.V.	7 402.07 .13	3 328.73 .03	1 397.54 -	3 343.20 .17		1 328.62 -		3 340.03 .08				4 402.90 .08	2 370.96 .16
5	N Mean C.V.						1 764.36 -							

TABLE 14

MEAN NURSING COST (DIRECT) AND DEGREE OF VARIABILITY
DIAGNOSIS RELATED GROUPS

Group		001	088	105	107	122	148	162	209	222	335	355	430	458
Total	N	89	106	63	128	85	68	80	137	219	115	151	130	32
	Mean	2;970.80	1,344.80	1,951.22	1,721.58	1,225.10	2,903:56	354.77	1,617.67	360.67	728.15	603.44	2,886.89	4,837.96
	C.V.	1.40	.93	.58	.41	.65	.76	.28	.99	.51	.65	.26	.93	.92
1	N	24	18	1		1		18		1	79	73	14	1
	Mean	1,141.48	556.99	1,602.25		505.75		314.03		59.50	596.51	552.62	1,260.13	1,130.50
	C.V.	.97	.87	-		-		.12		-	.52	.16	.82	-
2	N	29	40	33	83	46	16	57	104	137	32	75	62	8
	Mean	1,523.99	908.86	1,629.04	1,580.85	955.60	1,863.63	362.22	1,344.96	368.29	869.26	645.72	2,423.53	2,041.59
	C.V.	.80	.64	.44	.25	.44	.62	.25	.50	.54	.43	.29	.81	.86
3	N	29	45	28	42	38	50	5	30	81	4	3	50	21
	Mean	5,254.91	1,926.01	2,339.47	1,870.81	1,570.26	3,181.63	416.50	2,136.90	351.49	2,199.38	783.42	3,730.99	4,879.20
	C.V.	1.14	.73	.61	.42	.63	.75	.63	1.16	.44	.44	.12	.83	.52
4	N	7	3	1	3		1		3				4	2
	Mean	5,773.93	3,166.25	2,061.25	3,526.08		3,570.00		5,879.17				5,211.56	17,444.10
	C.V.	.76	.85	-	.71		-		.88				1.16	.48
5	N						1							
	Mean						4,972.50							
	C.V.						-							

TABLE 15

MEAN PER DIEM NURSING COST (DIRECT) AND DEGREE OF VARIABILITY BY SUBGROUP
DIAGNOSIS RELATED GROUPS

Group		001	088	105	107	122	148	162	209	222	335	355	430	458
1	N	24	18	1		1		18		1	79	73	14	1
	Mean	66.16	39.36	55.25		63.22		56.93		29.75	49.66	63.69	53.31	56.63
	C.V.	.34	.36					.06			.13	.10	.21	-
2	N	29	40	33	83	46	16	57	104	137	32	75	62	8
	Mean	90.34	63.41	134.16	131.66	88.32	89.67	71.19	83.25	78.44	69.93	76.14	84.25	81.36
	C.V.	.30	.22	.18	.14	.16	.15	.16	.11	.17	.18	.15	.23	.28
3	N	29	45	28	42	38	50	5	30	81	4	3	50	21
	Mean	158.14	134.43	174.08	168.84	123.69	135.13	117.02	127.44	114.38	124.07	106.60	138.06	173.42
	C.V.	.26	.24	.18	.13	.20	.26	.20	.19	.13	.24	.04	.27	.24
4	N	7	3	1	3		1		3				4	2
	Mean	368.07	274.73	343.54	289.20		274.62		286.03				348.90	316.76
	C.V.	.15	.03	-	.20				.09				.10	.19
5	N	-					1							
	Mean	-					710.36							
	C.V.	-					-							

TABLE 16

MEAN LENGTH OF STAY BY DRG SUBGROUP AND DEGREE OF VARIABILITY
DIAGNOSIS RELATED GROUPS

Group		001	088	105	107	122	148	162	209.	222	335	355	430	458
Total	ALOS C.V.	21.6 1.02	14.1 .65	13.3 .57	11.8 .31	11.4 .49	22.7 .67	5.2 .29	16.6 .71	4.1 .61	12.4 .49	8.6 .22	26.9 .76	27.5 .45
1	ALOS C.V.	17.3 .88	13.4 .70	29 -		8 -		5.6 .17		2 -	12.1 .53	8.7 .18	26 1.02	20 -
2	ALOS C.V.	17.9 .96	14.4 .61	13 .59	12.2 .28	10.6 .38	20.5 .47	5.2 .30	16.4 .53	4.8 .59	12.5 .40	8.5 .25	28 .70	22.6 .52
3	ALOS C.V.	30.1 1.00	14.2 .68	13.3 .54	11.1 .37	12.4 .56	23.9 .70	3.6 .61	16.9 1.11	3.1 .43	17.8 .39	7.3 .08	26.7 .76	27.2 .10
4.	ALOS C.V.	16.1 .73	11.3 .84	6 -	12 .60		13 -		20.7 .91				15 1.18	53.5 .30
5	ALOS C.V.						7 -							

APPENDIX E

FIGURES AND SENSITIVITY ANALYSIS OF CASE MIX BY SUBGROUP

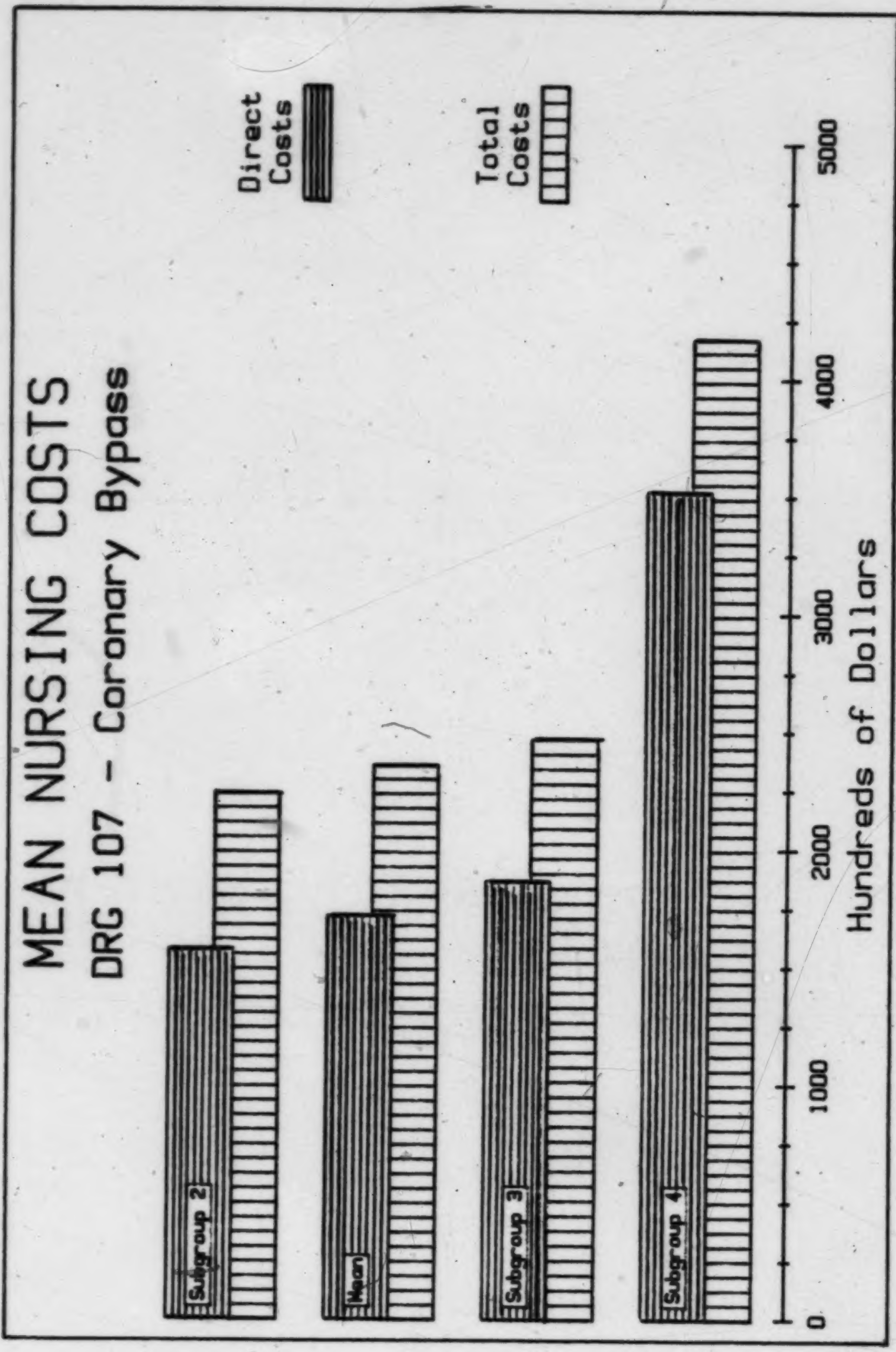
MEAN NURSING COSTS
DRG 107 - Coronary Bypass
Direct Costs
Total Costs
Subgroup 2
Mean
Subgroup 3
Subgroup 4
0
1000
2000
3000
4000
5000
Hundreds of Dollars

Figure 24

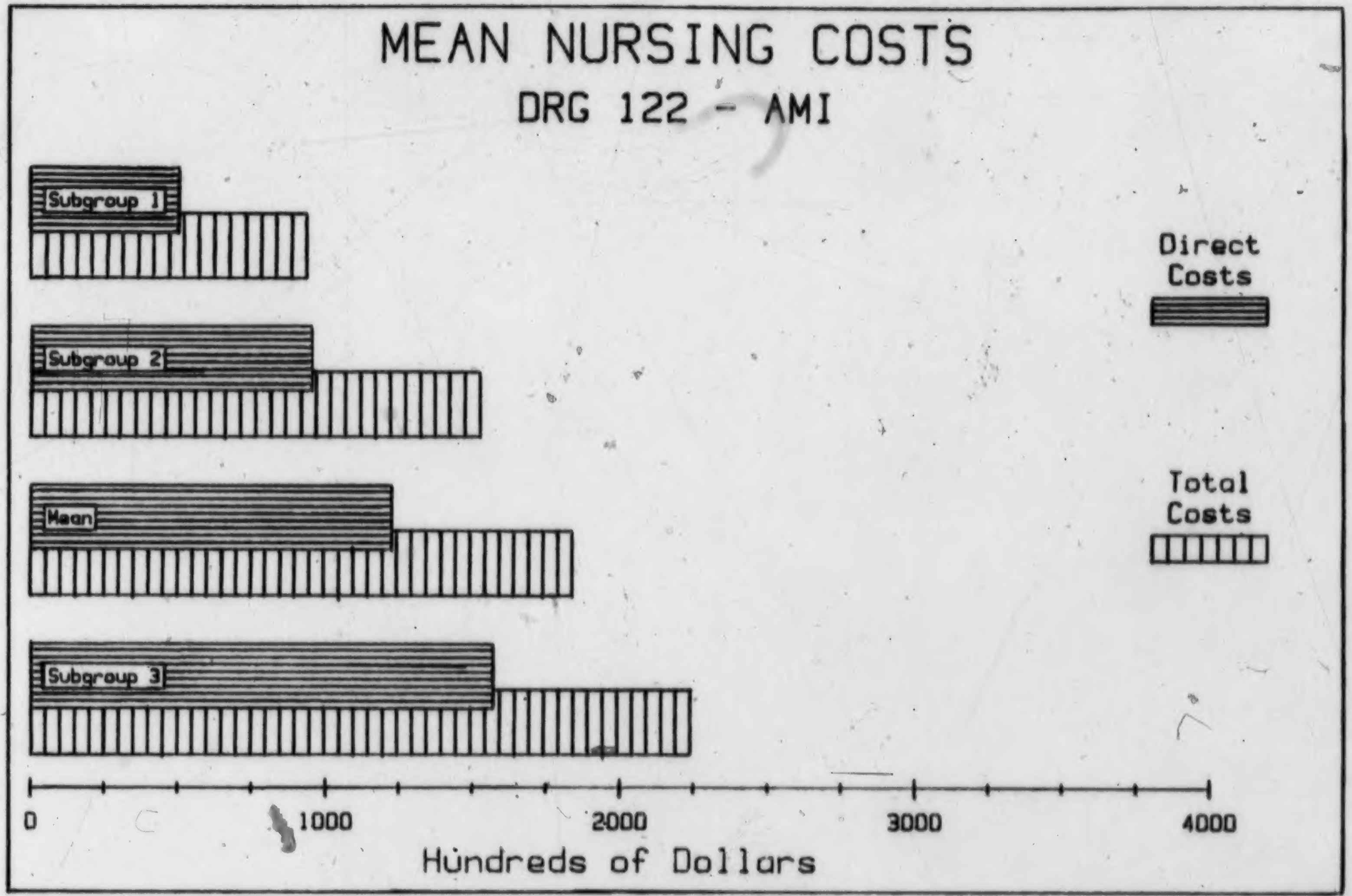
MEAN NURSING COSTS
DRG 122 - AMI
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Direct Costs
Total Costs
0
1000
2000
3000
4000
Hundreds of Dollars

Figure 25

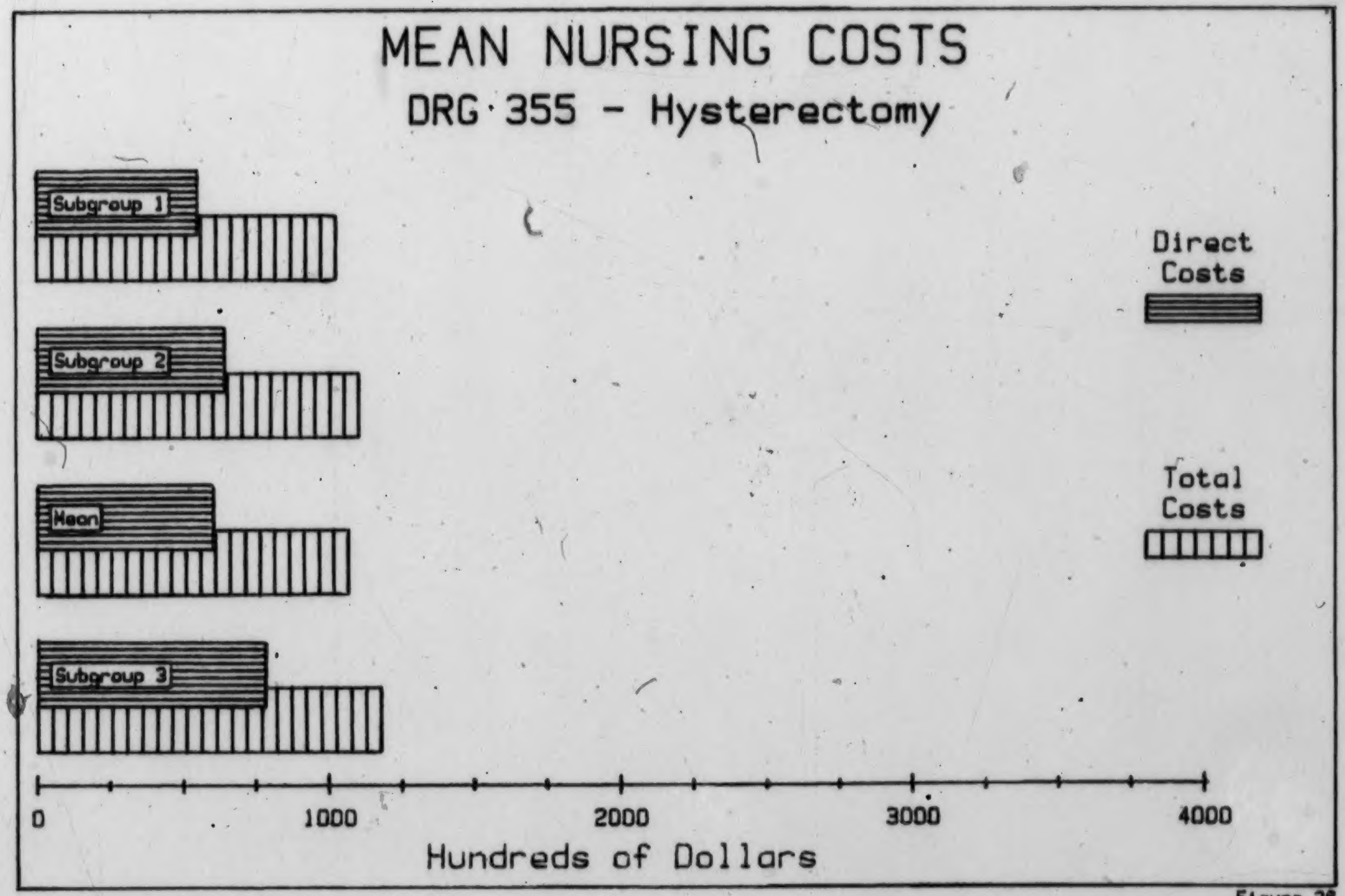
MEAN NURSING COSTS
DRG·355 - Hysterectomy
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Direct Costs
Total Costs
0
1000
2000
3000
4000
Hundreds of Dollars

Figure 26

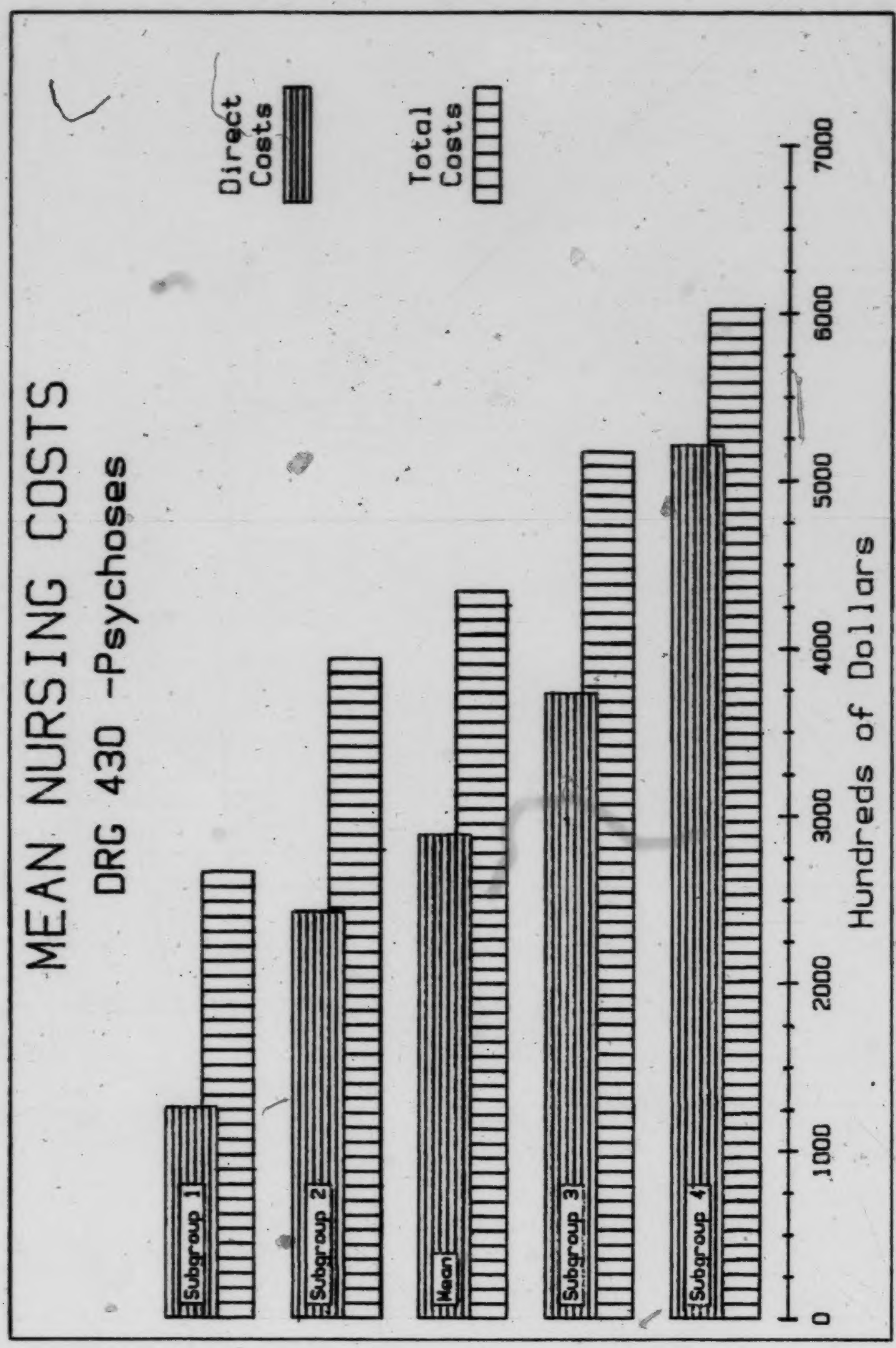
MEAN NURSING COSTS
DRG 430 -Psychoses
Direct Costs
Total Costs
Subgroup 1
Subgroup 2
Mean
Subgroup 3
Subgroup 4
0
1000
2000
3000
4000
5000
6000
7000
Hundreds of Dollars

Figure 27

Sensitivity Analysis of Case Mix

Sub Grps	N Value	Mean Costs	Current Costs	Percent Change	New N Value	New Costs	Chge in Cost
001 - Craniotomy							
Sub Grp 1	24	1141	27384	0.10	26	29666	2282
Sub Grp 2	29	1524	44196	0.10	32	48768	4572
Sub Grp 3	29	5255	152395	0.10	32	168160	15765
Sub Grp 4	7	5774	40418		10	57740	17322
	--		------		---	------	-----
TOTAL	89		264393		100	304334	39941
088 - COPD							
Sub Grp 1	18	557	10026	0.10	20	11140	1114
Sub Grp 2	40	909	36360	0.10	44	39996	3636
Sub Grp 3	45	1926	86670	0.10	50	96300	9630
Sub Grp 4	3	3166	9498		6	18996	9498
	--		------		---	------	-----
TOTAL	106		142554		120	166432	23878
105 - Cardiac Op							
Sub Grp 1	1	1602	1602	0.10	1	1602	0
Sub Grp 2	33	1629	53757	0.10	36	58644	4887
Sub Grp 3	28	2339	65492	0.10	31	72509	7017
Sub Grp 4	1	2061	2061		3	6183	4122
	--		------		---	------	-----
TOTAL	63		122912		71	138938	16026

Sub Grps	N Value	Mean Costs	Current Costs	Percent Change	New N Value	New Costs	Chge in Cost
107 - Coronary Bypass							
Sub Grp 1	0		0	0.10	0	0	0
Sub Grp 2	83	1581	131223	0.10	91	143871	12648
Sub Grp 3	42	1871	78582	0.10	46	86066	7484
Sub Grp 4	3	3526	10578		5	17630	7052
TOTAL	128		220383		142	247567	27184
122 - AMI							
Sub Grp 1	1	506	506	0.10	1	506	0
Sub Grp 2	46	956	43976	0.10	51	48756	4780
Sub Grp 3	38	1570	59660	0.10	42	65940	6280
Sub Grp 4	0	0	0		0	0	0
TOTAL	85		104142		94	115202	11060
148 - Major Intestinal Op							
Sub Grp 1	0	0	0	0.10	0	0	0
Sub Grp 2	16	1864	29824	0.10	18	33552	3728
Sub Grp 3	50	3181	159050	0.10	55	174955	15905
Sub Grp 4	1	3570	3570		4	14280	10710
TOTAL	67		192444		77	222787	30343
162 - Hernia Op							
Sub Grp 1	18	314	5652	0.10	20	6280	628
Sub Grp 2	57	362	20634	0.10	63	22806	2172
Sub Grp 3	5	417	2085		7	2919	834
Sub Grp 4	0	0	0		0	0	0
TOTAL			28371		90	32005	3634

```
                                Mean  Current  Percent      New     New  Chge in
         Sub Grps   N Value    Costs    Costs   Change  N Value   Costs     Cost
         ========   =======    =====  =======  =======  =======   =====  =======

209 - Major Joint Op
         Sub Grp 1        0        0        0     0.10        0       0        0
         Sub Grp 2      104     1345   139880     0.10      114  153330    13450
         Sub Grp 3       30     2136    64080     0.10       33   70488     6408
         Sub Grp 4        3     5879    17637                 5   29395    11758
                         --           ------                ---  ------    -----
             TOTAL      137           221597                152  253213    31616

222 - Knee Op
         Sub Grp 1        1       60       60     0.10        1      60        0
         Sub Grp 2      137      368    50416     0.10      151   55568     5152
         Sub Grp 3       81      351    28431     0.10       89   31239     2808
         Sub Grp 4        0        0        0                 0       0        0
                         --           ------                ---  ------    -----
             TOTAL      219            78907                241   86867     7960

335 - Pelvic Op, Male
         Sub Grp 1       79      597    47163     0.10       87   51939     4776
         Sub Grp 2       32      869    27808     0.10       35   30415     2607
         Sub Grp 3        4     2199     8796                 7   15393     6597
         Sub Grp 4        0        0        0                 0       0        0
                         --           ------                ---  ------    -----
             TOTAL      115            83767                129   97747    13980

355 - Hysterectomy
         Sub Grp 1       73      553    40369     0.10       80   44240     3871
         Sub Grp 2       75      646    48450     0.10       83   53618     5168
         Sub Grp 3        3      783     2349                 6    4698     2349
         Sub Grp 4        0        0        0                 0       0        0
                        ---           ------                ---  ------    -----
             TOTAL      151            91168                169  102556    11388
```

Sub Grps	N Value	Mean Costs	Current Costs	Percent Change	New N Value	New Costs	Chge in Cost
430 - Psychoses							
Sub Grp 1	14	1260	17640	0.10	15	18900	1260
Sub Grp 2	62	2423	150226	0.10	68	164764	14538
Sub Grp 3	50	3731	186550	0.10	55	205205	18655
Sub Grp 4	4	5212	20848		6	31272	10424
TOTAL	130		375264		144	420141	44877
458 - Burns							
Sub Grp 1	1	1131	1131	0.10	1	1131	0
Sub Grp 2	8	2042	16336	0.10	9	18378	2042
Sub Grp 3	21	4879	102459	0.10	23	112217	9758
Sub Grp 4	2	17444	34888		4	69776	34888
TOTAL	32		154814		37	201502	46688
GRAND TOTALS							
Sub Grp 1	230		151533		252	165464	13931
Sub Grp 2	722		793086		795	872466	79380
Sub Grp 3	426		996599		476	1106089	109490
Sub Grp 4	24		139498		43	245272	105774
TOTAL	1402		2080716		1566	2389291	308575

APPENDIX F

MEAN COSTS OF NURSING
VARIATION WITH AGE, TYPE OF ADMISSION AND CONDITION OF DISCHARGE

TABLE 17

MEAN DIRECT NURSING COST BY DRG - VARIATION WITH AGE

Group		001	088	105	107	122	148	162	209	222	335	355	430	458
49 & <	N	49	10	23	32	28	26	33	15	196	4	120	101	26
	Mean	2,170.19	734.83	1,559.57	1,509.95	1,019.24	2,644.97	340.77	1,428.00	371.12	1,160.25	579.10	2,654.19	5,235.35
50 & >	N	40	96	40	96	57	42	47	122	23	111	31	29	6
	Mean	3,951.54	1,408.34	2,176.42	1,792.13	1,326.22	3,063.44	364.50	1,640.99	271.63	712.58	697.69	3,697.35	3,115.96
59 & <	N	65	34	44	80	49	35	60	37	213	15	142	114	30
	Mean	2,441.40	1,078.50	1,830.01	1,647.62	1,091.73	2,714.54	346.09	1,471.42	363.98	755.65	598.32	2,675.19	4,860.02
60 & >	N	24	72	19	48	36	33	20	100	6	100	9	16	2
	Mean	4,404.59	1,470.56	2,231.92	1,844.85	1,406.63	3,104.05	380.80	1,671.78	242.96	724.03	684.25	4,395.30	4,507.13
64 & <	N	76	51	51	107	64	43	69	63	217	32	145	121	31
	Mean	2,434.97	1,242.83	1,811.33	1,639.94	1,118.02	2,709.62	349.24	1,577.49	362.90	712.14	596.41	2,790.81	4,768.50
65 & >	N	13	55	12	21	21	25	11	74	2	83	6	9	1
	Mean	6,103.33	1,439.36	2,545.75	2,137.55	1,551.45	3,237.14	389.46	1,651.87	119.00	734.33	773.50	4,178.69	6,991.25
69 & <	N	83	69	56	122	71	48	80	81	219	56	151	125	31
	Mean	2,510.62	1,282.58	1,918.04	1,735.92	1,113.32	2,812.53	354.77	1,488.39	360.67	693.81	603.44	2,848.69	4,768.50
70 & >	N	6	37	7	6	14	20	-	56	-	59	-	5	1
	Mean	9,336.54	1,460.85	2,216.68	1,430.13	1,791.98	3,122.05	-	1,804.66	-	760.75	-	3,842.00	6,991.25

TABLE 18

MEAN TOTAL NURSING COST BY DRG - VARIATION WITH AGE

DRG		001	088	105	107	122	148	162	209	222	335	355	430	458
49 & <	N	49	10	23	32	28	26	33	15	196	4	120	101	26
	Mean	3,153.21	1,193.82	2,184.09	2,085.28	1,526.46	3,766.51	605.86	2,414.40	597.86	2,159.25	1,029.55	4,012.74	6,795.12
50 & >	N	40	96	40	96	57	42	47	122	23	111	31	29	6
	Mean	5,342.04	2,198.09	2,944.57	2,451.38	1,991.28	4,350.64	656.43	2,528.45	461.80	1,371.29	1,213.30	5,470.04	4,276.96
59 & <	N	65	34	44	80	49	35	60	37	213	15	142	114	30
	Mean	3,443.30	1,720.15	2,517.28	2,261.87	1,646.06	3,860.88	619.69	2,447.80	588.10	1,508.05	1,059.98	4,082.50	6,350.42
60 & >	N	24	72	19	48	36	33	20	100	6	100	9	16	2
	Mean	6,015.59	2,284.31	3,013.50	2,523.23	2,099.63	4,409.86	683.20	2,541.18	422.96	1,382.29	1,182.25	6,157.05	5,911.13
64 & <	N	76	51	51	107	64	43	69	63	217	32	145	121	31
	Mean	3,452.44	2,044.36	2,486.86	2,262.21	1,692.61	3,890.09	626.28	2,525.49	586.86	1,429.33	1,056.71	4,213.55	6,238.69
65 & >	N	13	55	12	21	21	25	11	74	2	83	6	9	1
	Mean	8,138.71	2,158.05	3,432.25	2,857.55	2,281.74	4,535.30	693.82	2,507.84	227.00	1,386.88	1,322.50	6,008.69	8,935.25
69 & <	N	83	69	56	122	71	48	80	81	219	56	151	125	31
	Mean	3,554.19	2,087.88	2,638.36	2,378.60	1,687.55	4,043.28	635.57	2,391.06	583.57	1,396.78	1,067.27	4,287.25	6,238.69
70 & >	N	6	37	7	6	14	20	-	56	-	59	-	5	1
	Mean	12,198.50	2,132.20	2,895.54	1,979.13	2,601.98	4,328.95	-	2,696.62	-	1,400.51	-	5,602.40	8,935.25

TABLE 19

MEAN DIRECT NURSING COST BY TYPE OF ADMISSION

Type		001	088	105	107	122	148	162	209	222	335	355	430	458
Elective	N Mean	40 2,101.94	38 1,003.89	56 1,997.20	98 1,720.43	6 565.25	29 2,607.30	78 348.61	103 1,459.48	154 358.16	91 642.36	148 602.61	96 2,677.32	4 1,108.19
Urgent	N Mean	49 3,680.07	68 1,535.31	7 1,583.43	30 1,725.36	79 1,275.22	39 3,123.86	2 595.00	34 2,096.88	65 366.61	24 1,053.47	3 644.58	34 3,478.63	28 5,370.79

TABLE 20

MEAN TOTAL NURSING COST BY TYPE OF ADMISSION

Type		001	088	105	107	122	148	162	209	222	335	355	430	458
Elective	N Mean	40 3,010.49	38 1,794.00	56 2,736.80	98 2,354.65	6 862.25	29 3,836.27	78 628.30	103 2,372.24	154 585.73	91 1,286.20	148 1,064.53	96 4,094.82	4 1,945.19
Urgent	N Mean	49 5,056.52	68 2,276.22	7 2,108.00	30 2,376.96	79 1,912.28	39 4,343.71	2 919.00	34 2,951.35	65 578.46	24 1,825.22	3 1,202.58	34 5,023.98	28 6,948.36

TABLE 21

MEAN DIRECT NURSING COST BY CONDITION AT DISCHARGE*

DRG		001	088	105	107	122	148	162	209	222	335	355	430	458
Condition 1	N	63	84	50	115	82	52	80	52	215	111	150	125	32
	Mean	1,843.15	1,061.03	1,941.31	1,681.85	1,191.87	2,766.01	354.77	1,288.65	356.45	697.08	603.90	2,892.86	4,837.96
2	N	4	10	9	4		8		3					
	Mean	7,091.13	3,622.27	1,309.47	2,544.69		2,792.25		2,459.33					
3	N	22	12	4	9	3	8		82	4	4	1	5	
	Mean	5,450.82	1,433.31	3,519.00	1,863.39	2,133.50	3,908.94		1,795.52	587.56	1,590.56	535.50	2,737.85	

TABLE 22

MEAN TOTAL NURSING COST BY CONDITION AT DISCHARGE*

DRG		001	088	105	107	122	148	162	209	222	335	355	430	458
Condition 1	N	63	84	50	115	82	52	80	52	215	111	150	125	32
	Mean	2,864.01	1,784.25	2,691.91	2,323.28	1,799.04	3,997.63	635.57	2,081.00	576.97	1,365.02	1,067.94	4,359.93	6,322.96
2	N	4	10	9	4		8		3					
	Mean	8,252.13	4,848.07	1,663.47	3,125.19		3,561.75		3,053.33					
3	N	22	12	4	9	3	8		82	4	4	1	5	
	Mean	7,034.00	2,049.81	4,612.50	2,487.39	2,907.50	5,535.69		2,772.13	938.56	2,333.06	967.50	3,785.45	

* 1 = Discharged Home; 2 = Deceased; 3 = Transfer to Other Facility.

Sensitivity Analysis - Age 65 and Over

DRG's	001	088	105	107	122	148	162
N	13	55	12	21	21	25	11
Mean	6103	1439	2546	2138	1551	3237	389
	79339	79145	30552	44898	32571	80925	4279

DRG's	209	222	335	355	430	458	Total
N	74	2	83	6	9	1	333
Mean	1652	119	734	774	4179	6991	
	122248	238	60922	4644	37611	6991	584363

Percent Increase in Number of Patients 65 and Over 0.10

DRG's	001	088	105	107	122	148	162
N	14	61	13	23	23	28	12
Mean	6103	1439	2546	2138	1551	3237	389
	85442	87779	33098	49174	35673	90636	4668

DRG's	209	222	335	355	430	458	Total
N	81	2	91	7	10	1	366
Mean	1652	119	734	774	4179	6991	
	133812	238	66794	5418	41790	6991	641513

APPENDIX G

ANALYSIS OF VARIANCE RESULTS

TABLE 23

PROCEDURE GLM BY DRG SUBGROUP

GROUP	# DRGs	N	DIRECT COST		TOTAL COST		PER DIEM COST		DIRECT MEAN COST
			F	P	F	P	F	P	
Total Sample	12	1,371	41.02	.0001	46.17	.0001	51.48	.0001	$1,408.43
SG 1	9	229	7.80	.0001	7.69	.0001	19.29	.0001	656.54
SG 2	12	714	44.17	.0001	42.79	.0001	119.83	.0001	1,087.92
SG 3	12	405	12.69	.0001	13.22	.0001	16.14	.0001	2,208.03
SG 4	7	23	.28	.9401	.27	.9430	1.66	.1963	4,764.43

TABLE 24

PROCEDURE GLM BY AGE SUBDIVISIONS

AGE	# DRGs	N	DIRECT COST FTest	DIRECT COST P	TOTAL COST FTest	TOTAL COST P	MEAN DIRECT COST	MEAN TOTAL COST
49 <	12	637	24.04	.0001	28.78	.0001	1,166.08	1,781.70
50 >	12	734	20.77	.0001	21.50	.0001	1,618.75	2,414.77
Total	12	1,371	22.01	.0001	24.47	.0001	1,408.43	2,120.63
59 <	12	888	32.98	.0001	38.50	.0001	1,250.22	1,893.42
60 >		483	13.16	.0001	13.23	.0001	1,699.30	2,538.36
Total	12	1,371	22.23	.0001	24.64	.0001	1,408.43	2,120.63
64 <	12	1,039	37.43	.0001	43.34	.0001	1,302.74	1,972.67
65 >	12	332	10.91	.0001	10.80	.0001	1,739.20	2,583.68
Total	12	1,371	23.73	.0001	26.09	.0001		
69 <	12	1,161	43.71	.0001	49.64	.0001	1,329.98	2,014.21
70 >	9	210	11.54	.0001	11.26	.0001	1,842.15	2,708.98
Sample	12	1,371	30.07	.0001	32.57	.0001		

TABLE 25

PROCEDURE GLM - BY TYPE OF ADMISSION

ATYPE	# DRGs	N	DIRECT COST FTest	DIRECT COST P	TOTAL COST FTest	TOTAL COST P	MEAN DIRECT COST	MEAN TOTAL COST
Elective	12	937	30.09	.0001	33.91	.0001	1,194.25	1,857.29
Urgent	12	434	11.67	.0001	13.05	.0001	1,870.84	2,689.18
SAMPLE	12	1,371	21.71	.0001	23.90	.0001	1,408.43	2,120.63

TABLE 26

PROCEDURE GLM BY CONDITION AT DISCHARGE*

			DIRECT COST		TOTAL COST		MEAN DIRECT COST	MEAN TOTAL COST
CDIS	# DRGs	N	FTest	P.	FTest	P		
1	12	1,179	51.29	.0001	55.87	.0001	1,220.43	1,889.13
2	6	38	3.51	.0122	3.45	.0133	3,059.66	3,858.30
3	11	154	3.49	.0004	3.14	.0012	2,440.30	3,464.20
SAMPLE	12	1,371	23.69	.0001	24.00	.0001	1,408.43	2,120.63

* 1 = Discharged Home; 2 = Deceased; 3 = Transfer to Other Facility.

TABLE 27 GLM PROCEDURE BY DRG

DRG	N		DIRECT COST		PER DIEM COST	
		Levels	F Test	P	F Test	P
001	89	4	8.33	.0001	146.92	.0001
088	106	4	12.50	.0001	156.93	.0001
105	63	4	2.12	.1060	30.64	.0001
107	128	3	15.36	.0001	116.04	.0001
122	85	3	7.70	.0009	35.68	.0001
148	68	4	1.83	.1495	126.60	.0001
162	80	3	2.68	.0748	59.29	.0001
209	137	3	16.96	.0001	390.65	.0001
222	219	3	1.58	.2082	180.84	.0001
335	115	3	41.15	.0001	147.25	.0001
355	151	3	9.64	.0001	59.39	.0001
430	130	4	5.46	.0016	150.07	.0001

TABLE 28

PROCEDURE GLM - AGE BY DRG

DRG	AGE 50 DIRECT COST F	P	AGE 60 DIRECT COST F	P	AGE 65 DIRECT COST F	P	AGE 70 DIRECT COST F	P	MEAN AGE	N
001	4.17	.0442	4.02	.0480	9.42	.0029	17.89	.0001	48	89
088	2.68	.1045	2.31	.1316	.65	.4203	.49	.4857	63	106
105	4.55	.0369	1.68	.1999	4.28	.0429	.43	.5164	52	63
107	3.97	.0485	2.39	.1243	9.41	.0026	1.09	.2994	55	128
122	2.86	.0943	3.35	.0708	4.92	.0292	9.38	.0030	57	85
148	.57	.4526	.52	.4724	.90	.3471	.27	.6030	56	68
162	1.09	.3001	1.80	.1832	1.53	.2204			50	80
209	.26	.6283	.42	.5171	.07	.7873	1.30	.2568	66	137
222	6.22	.0136	2.57	.1106	3.56	.0607	-	-	29	219
335	3.58	.0609	.06	.8092	.05	.8216	.58	.6476	70	115
355	15.67	.0001	2.60	.1088	7.78	.0060	-	-	42	151
430	3.45	.0657	5.94	.0161	2.25	.1364	.65	.4207	37	130

TABLE 29

PROCEDURE GLM - ADMISSION TYPE AND CONDITION AT DISCHARGE BY DRG

			CONDITION AT DISCHARGE				TYPE OF ADMISSION				
			DIRECT COST		PER DIEM COST			DIECT COST		PER DIEM COST	
DRG	N	LEVELS	FTest	P	FTest	P	LEVELS	FTest	P	FTest	P
001	89	3	9.78	.0001	39.04	.0001	2	3.24	.0755	6.70	.0113
088	106	3	28.90	.0001	23.52	.0001	2	4.58	.0348	23.78	.0001
105	63	3	6.11	.0038	3.54	.0353	2	.82	.3678	.47	.4951
107	128	3	3.23	.0430	21.32	.0001	2	.00	.9733	.10	.7533
122	85	2	4.22	.0431	3.06	.0839	2	4.64	.0341	1.98	.1631
148	68	3	.93	.3982	9.07	.0003	2	.90	.3450	3.27	.0752
162	80	1					2	13.55	.0004	5.91	.0173
209	137	3	2.05	.1323	29.39	.0001	2	4.15	.0435	47.16	.0001
222	219	2	6.41	.0121	.28	.5942	2	.10	.7558	8.39	.0042
335	115	2	45.76	.0001	41.87	.0001	2	16.51	.0001	17.34	.0001
355	151	2	.19	.6632	.10	.7532	2	.21	.6456	1.08	.3002
410	130	2	.02	.9001	27.27	.0001	2	2.24	.1356	6.7[illegible]	.0104

TABLE 30

PROCEDURE GLM - LOS BY DRG

	TOTAL	001	088	105	107	122	148	162	209	222	335	355	430
F	52.24	2.25	.13	1.81	1.20	1.34	1.01	3.47	.20	12.93	1.64	1.03	.51
P	.0001	.0865	.9379	.1539	.3053	.2677	.3714	.0360	.8221	.0001	.1977	.3590	.6779

TABLE 31

PROCEDURE GLM - RESULTS FOR SELECTED DRGs BY SUBGROUP

SUBGROUP	DRG	N	TOTAL COST			DIRECT COST			PER DIEM COST		
			F	P	MEAN	F	P	MEAN	F	P	MEAN
	001,148,430*										
1	2	38	.68	.4159	2,292.19	.11	.7464	1,185.19	3.99	.0534	61.43
2	3	107	3.29	.0412	3,400.00	2.97	.0559	2,096.00	.98	.3795	86.71
3	3	129	2.30	.1040	5,283.90	2.90	.0590	3,860.65	3.74	.0264	141.44
4	3	12	.08	.9248	6,239.81	.09	.9152	5,402.81	1.15	.3578	342.22
	105,107,122										
1	2	2	99,999.9	.0000	2,053.00	99,999.99	.0000	1,054.00	99,999.99	.0000	59.23
2	3	162	17.39	.0001	2,055.13	28.97	.0001	1,413.13	95.46	.0001	119.86
3	3	108	2.98	.0549	2,540.57	4.28	.0164	1,886.57	41.13	.0001	154.31
4	2	4	.29	.6454	3,726.88	.25	.6647	3,159.88	.67	.4978	302.78

*In this analysis, DRG #148, level 4, excludes the patient in subgroup 5.